THE Petroleum Engineer

ALL DIVISIONS

- Exploration Drilling and Production
- Refining and Gas Processing
- Oil and Gas Pipelining

SEPTEMBER, 1950 • VOLUME XXII • NUMBER 10

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RENEGOTIATION!

A TREMENDOUS effort has been put forth by the oil industry during the last four years to build up domestic oil reserves. It felt compelled to do so because of the abnormal depletion of oil resources that occurred in supplying the inordinate demands of World War II. This effort has borne fruit. Today domestic crude oil production capacity is about one million barrels daily in excess of the demand. How long this favorable situation will obtain hinges on what course world events will take in the immediate future.

The industry is now operating at its highest level in history. September State of Texas allowables are set at about 100,000 bbl a day higher than the peak of December, 1948. Oil production of that State will run between 2,600,000 and 2,800,000 bbl a day, equal to a total monthly production of about 88,000,000 bbl. Refineries are now operating at 90 per cent of capacity. More than 6,000,000 bbl a day were processed the week of August 14. This rate of throughput was about 370,000 bbl in excess of crude produced from wells during that same week.

Despite this display of the oil industry's ability to cope with the exigencies of war, there is apprehension among oil industry leaders regarding the imposition of government controls that could seriously hamper the industry's war effort. Causing particular concern is a pending bill covering the renegotiation of war contracts. If passed it would supersede the renegotiation law that was in force during World War II. Under the proposed bill, the production of crude oil, a raw material and a vital natural resource in time of war, would be subject to renegotiation.

The industry has gone on record in opposing the inclusion of crude oil in this bill. A spokesman for the industry in a statement before the House Ways and Means Committee on August 11, pointed out the basic difference between finished products and crude oil, a raw material. Crude oil is a vanishing asset and is not replaceable. When a barrel of oil is produced it represents the depletion of a capital asset. A crude oil producer who sells part of his assets has that much less to sell. This very fact, it was emphasized, puts a premium on non-cooperation with the war effort and really penalizes the producer who does cooperate. Another spokesman made the pointed statement that renegotiation could nullify the effect of the depletion allowance. Between 1937 and 1946 the industry spent two billion dollars more developing new oil reserves than it received from the statutory depletion allowance. It is also to be noted that the oil industry normally reinvests 60 per cent of its total income in exploration and development.

What the industry has accomplished gives substance to a statement of Chairman Hallanan of the National Petroleum Council, that "We are geared to provide the essential ammunition of oil to meet any foreseeable requirement." Making crude oil production subject to renegotiation would be a body blow that could cripple the industry's entire war effort. In the circumstances, it is unthinkable.—K.C.S.

Speeds Double-Jointing on Tennessee Line with "AUTOMATIC LINCOLNWELD"

THIRTY INCH pipe on the Tennessee spread was recently double jointed at welding speeds of 54 to 60 inches per minute using the hidden-arc process. (Fig. 1). With a crew of 18 to 22 men, depending on local labor conditions, an average of 8 to 10 double joints are completed every hour, including the handling time of the 60-foot double-jointed length.

Pipe sections are mounted on floating roller supports and the joint first lined up, spaced, and tack welded with "Shield-Arc 85" electrode, 3/16" size, followed by completion of a stringer bead, hand welded with 3/16" electrode, with usual procedure to rotate the pipe while the stringer is being made.

Two welding passes are made with the "Automatic Lincolnweld" using 575 to 650 amperes on the filler pass and 625 to 700 amperes on the cap pass. Welding current is supplied by two Lincoln 400 amp. "Shield-Arc" engine-driven arc welders (Fig. 2) connected in parallel. The "Lincolnweld" head is "float-mounted" to follow the contour of the pipe and compensate for any out of roundness.

All welds are x-ray inspected and found to be completely free from porosity and possess 100% penetration.

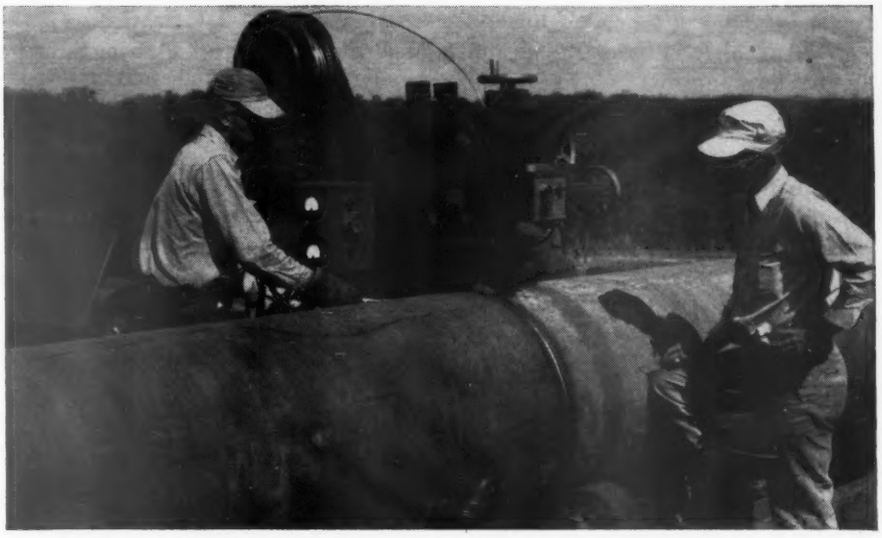


Fig. 1. *Double jointing 30" pipe on the Tennessee Gas Transmission Line with "Automatic Lincolnweld." Sub-contractor, The Shamrock Construction Co.*

Fig. 3. *High quality, uniform weld bead produced with "Automatic Lincolnweld."*

Fig. 2. *Heavy sustained welding current for double jointing operation is supplied by two Lincoln "Shield-Arc" engine driven arc welders.*

Fig. 4. *Downhand welding of stringer bead prior to welding with "Automatic Lincolnweld".*

GET THE FACTS

Write for Lincolnweld Bulletin 439

THE LINCOLN ELECTRIC COMPANY

Dept. 186, Cleveland 1, Ohio

Sales Offices and Field Service Shops in All Principal Cities

LINCOLN

HIGHLIGHTS IN OILDOM

Additional Oil Ready. In case of an emergency, present oil production can be increased nearly a million and a half barrels a day, the 20-member states of the Interstate Oil Compact Commission has informed President Truman. The Commission further added that without waste, 1,492,601 more barrels can be produced per day.

Survey of Oil Storage. A resurvey on oil storage has been advocated by the oil industry to determine amount of facilities available as the industry prepares to meet increasing demands for its products. The last report on available storage facilities was made in 1948, showing tankage at storage terminals was 416,727,000 bbl. An industry spokesman remarked that some tankage reported in 1948 may have been moved or abandoned and some new tankage may have been provided.

Report on Fuels. A bill proposing a complete study of the nation's fuel reserves with the purpose of formulating a National Fuel Policy for war and peace has been introduced. The resolution would provide for an investigation and study of available fuel reserves of the U. S., recommend methods of further developments, and report to the Senate not later than January 1, 1951 the results of its investigations together with its recommendations.

Gas Heat Users Double. Consumers Gas Company will add more gas space-heating customers in 1950 alone than it had expected to acquire during the next 5 years, a company official has announced. The some 51,000 new space-heating customers is expected to increase to twice the amount at the beginning of this year, Justin R. Whiting president, has announced.

May Double Crude Supply. Domestic crude oil production may average 5,600,000 bbl daily during August, almost 450,000 bbl more than previous estimates for the third quarter of 1950, according to an estimate made by H. B. Fell, executive vice president of IPAA. This anticipated supply, coupled with imports of 800,000 bbl daily and natural gasoline output of 500,000 bbl, would boost total oil supply to about 6,900,000 bbl a day for the month.

Study Steel Needs. Six subcommittees have been named by the National Petroleum Council committee, which is preparing a report on petroleum steel requirements for the last half of 1950 and all of 1951 by quarterly periods. As an aid to the NPC committee the oil and gas division of the Department of Interior has supplied estimates of demand for all oils—including military and export—through 1952. These estimates were:

Years	Total Demand (Barrels Daily)
1950	6,700,000 to 6,800,000
1951	7,000,000 to 7,100,000
1952	7,200,000 to 7,300,000

Prices Rise. The rapid rise in oil production has brought an overall increase in price. This puts otherwise uneconomical wells into production.

The Oil Front

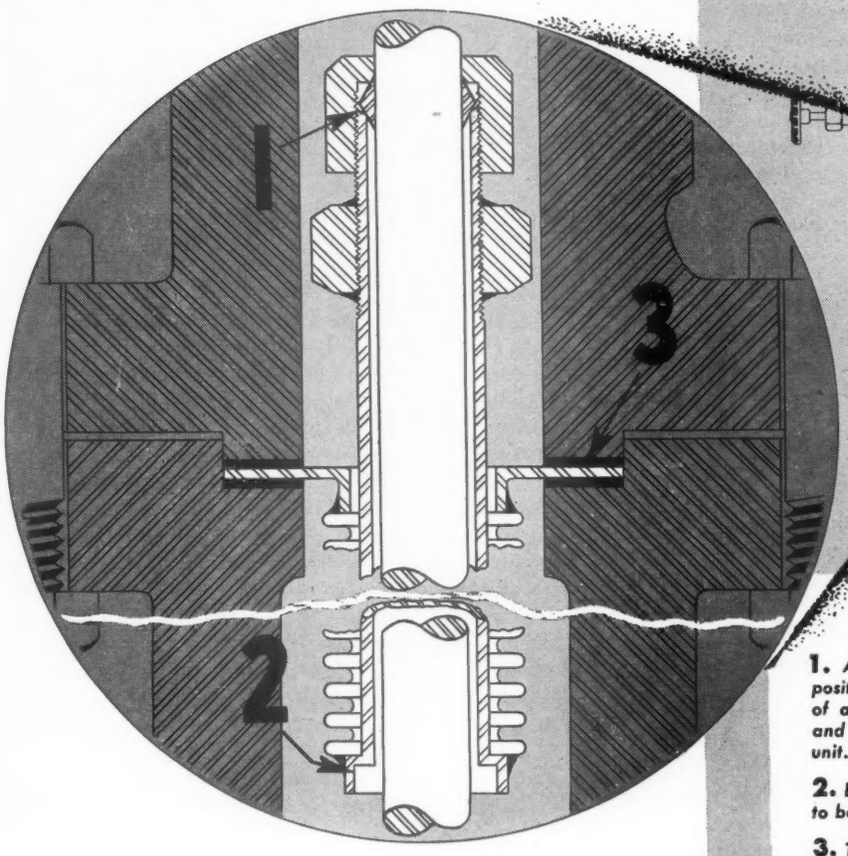
"DON'T BEEF TO ME!---WHOSE IDEA WAS IT TO SELL THE PIPELINE RIGHT-OF-WAY THRU HERE?"

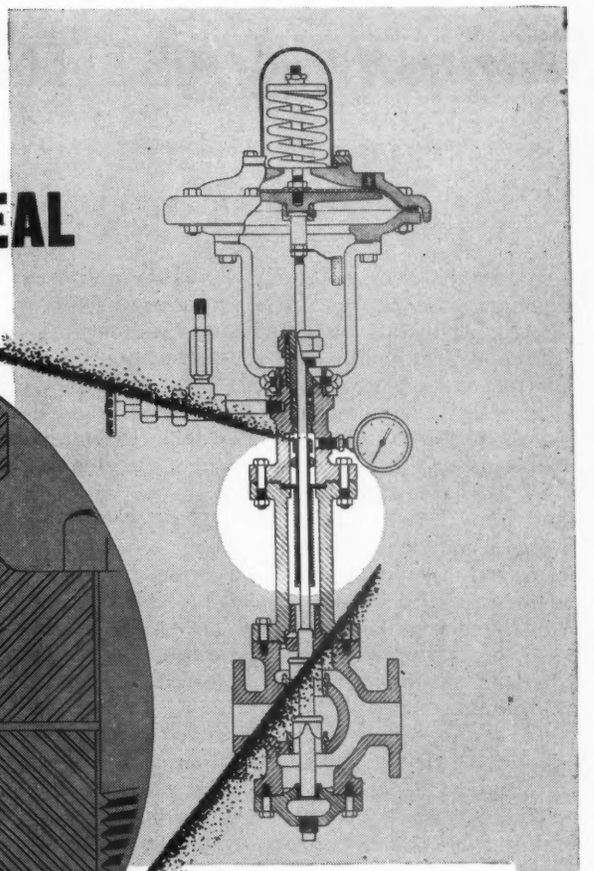
U. S. Oil Stocks Seized. Oil stocks of three American firms and a British company have been seized by Chinese Communist troops the Peiping radio has reported. According to the broadcast, the stocks were the property of the ECA and therefore had become the property of the Communist government. The ECA had a mission in China before the Nationalist collapse. Stocks, size of which was not given, were taken from the Caltex Company, Standard Vacuum, Cathay Oil, and the British Asiatic Petroleum Company (Shell) and were shipped to Peiping the radio reported. It also claimed that these firms had ignored an order to surrender the oil claiming it was their private property and not that of ECA.

Boost Flow Rate. Texas oil allowables reached an all-time high this month. A record 2,823,720 bbl daily are being produced in September, with East Texas on a 21-day basis and the rest of the state on a 22-day basis. War and civilian demand increases caused the Railroad Commission to increase Texas' production 202,836 bbl over last month's oil output. Since March, that state's permissible output has gained 879,000 bbl of crude. Besides crude oil, the state will supply 305,000 bbl of liquid fuels a day from gas.

Tidelands Costs High. The search for oil in the tidelands has been a costly one. In their exploration of the Gulf of Mexico, oil companies have spent $234,000,000; their total revenue to June 1 amounted to $6,300,000. Humble Oil and Refining Company has expended more than $50,000,000 in the Gulf and has received $670,000. Total deficit on the operations of all companies in the Gulf is about $230,000,000 and that of Humble is $50,000,000. Revenues are now about $870,000. These figures were revealed by Rex G. Baker, Humble's general counsel, before a Senate committee, discussing the proposed "interim" bill.

NOW! Stabilflo Valves with NEW, POSITIVE BELLOWS-SEAL





● Here's an automatic process control valve with a positive, safe, yet *simply-constructed* seal . . . for use wherever toxic, corrosive or precious fluids are involved. The Foxboro Stabilflo Valve is now available with a new-design, bellows-sealed valve stem. Instead of the conventional stuffing box, the packless bellows assembly makes a positive seal between the valve stem and valve body. The bellows expands and contracts with reciprocating action of valve stem.

Over the past nine years, Foxboro has pioneered in the development and application of bellows-sealed control valves for *special* jobs. This improved design is the outcome! It removes bellows-sealed valves from the class of "specials" because of its unique simplicity.

FEATURES

1. *A close-clearance liner guide is positively sealed to valve stem by means of a stainless steel compression ferrule and locknut. Stem and liner move as unit.*

2. *Bottom of liner guide is seam-welded to bottom of bellows.*

3. *Top of bellows is seam-welded to flange, which in turn is gasket-sealed between valve bonnet and bellows housing.*

Bellows assemblies are made of Type 347 Stainless Steel. *Replacement involves only the bellows and ferrule* . . . readily accomplished in field.

The new-design bellows-seal assembly can be applied to any standard Stabilflo Valve in sizes through 4 inches.

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FOXBORO REG. U. S. PAT. OFF. **INSTRUMENTATION**

Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON.—There is a battle raging within the Truman Administration over who gets what under the new defense production legislation with the Interior Department still hopeful of getting priorities, allocations, and inventory controls over oil, gas, and coal.

Secretary Chapman believes that this would not require the establishment of a new Petroleum Administration for War—not at the outset, anyway. So, the charter for a new PAW has been put on ice in case the war situation worsens and more detailed regulation of the petroleum industry becomes necessary.

Instead, Chapman plans to set up—within the department—a new fuels-and-energy administration under which would be placed the present Oil and Gas Division. Chapman has been talking to Ralph K. Davies (Ex-PAW) trying to persuade him to head up this overall fuels-and-energy organization.

For the present, President Truman would prefer to hang on to the price control and rationing powers of the new legislation, without delegating them either to existing agencies or some new overall organization, like OPA. It may require quite some time to work out the administrative details. Anyway, this serves Truman's purpose of avoiding application of the more stringent controls until after the fall elections.

Interior could impose conditions on the use of materials allocated to producers—well spacing, for example. Also, if a producer stockpiles more than Interior thinks he needs then his inventory could be redistributed among the have-not producers. Another function of Interior would be the allocation of supplies down to the retail level in case a shortage of oil, gas, or coal develops.

▸ **Voluntary Agreements.** One of the first provisions of the new legislation likely to be invoked is that providing antitrust clearance for voluntary programs and agreements. Joint action will be needed to supply the military's requirements of aviation gasoline, swapping and cutting back on the octane ratings of motor fuels to free more alkylate for avgas. But the industry has studiously avoided any steps in this direction, pending the development of procedure that would assure protection against "another Madison oil case."

Another field for cooperative action might be the voluntary allocation of crude to small refiners with inadequate supplies of their own to make military products.

All refiners are now being canvassed as to their facilities for making avgas and what they would need to increase their output. These replies will be studied by the aviation gasoline subcommittee and an analysis presented at the MPAB's next meeting here, September 21-22.

▸ **Lube Oils.** The military has had difficulty in obtaining coverage of its bid call for an additional twelve million gallons of lubricating oils, mostly motor oils, for delivery by the end of this year. Most of this lube oil is to be packaged in five-gallon cans. Several refiners have reported trouble obtaining containers, so they have appealed to the government for priorities. Even before the Korean war had stepped up military requirements, the lube oil situation had tightened up. For example, stocks of Pennsylvania Grade bright stocks and neutrals, at the end of June, were down to about half the level of June, 1949.

▸ **Pipe Lines.** There is considerable political spadework being done at high levels here on behalf of the proposed Texas-California crude oil pipe line, to be financed by the government. Meanwhile, two other new pipe line projects have been mentioned. One would be a 20-in. crude line from Rocky Mountains to Illinois, sponsored by several major companies. The other is a 20-in. products line from Beaumont to St. Louis, reportedly to be financed with insurance company money. Expansion of the Plantation Pipeline to 167,000 bbl a day will provide room to take in another major company shipper as well as several smaller companies; at present, this products line hauls for eight companies besides the three owner-shippers.

▸ **Tidelands.** Speaker Rayburn of Texas has taken a hand in the tidelands stalemate, hoping that he can work out with the Interior and Justice departments some compromise on stop-gap legislation that would freeze the status quo, satisfying all parties concerned sufficiently to permit continued operation of these oil properties. It seems like a hopeless task. But the military urgently wants the tidelands oil to be developed and available. And this may decide the issue.

If all else fails, the military may put pressure on Secretary Chapman to enter into some sort of stipulation covering the Texas-Louisiana offshore operations. It might be patterned after the recently renegotiated stipulation with California, which allows the state to continue management of operations but under supervision of the Interior Department. Meanwhile, Texas has a petition pending before the Supreme Court for a rehearing, which won't be decided until the October term.

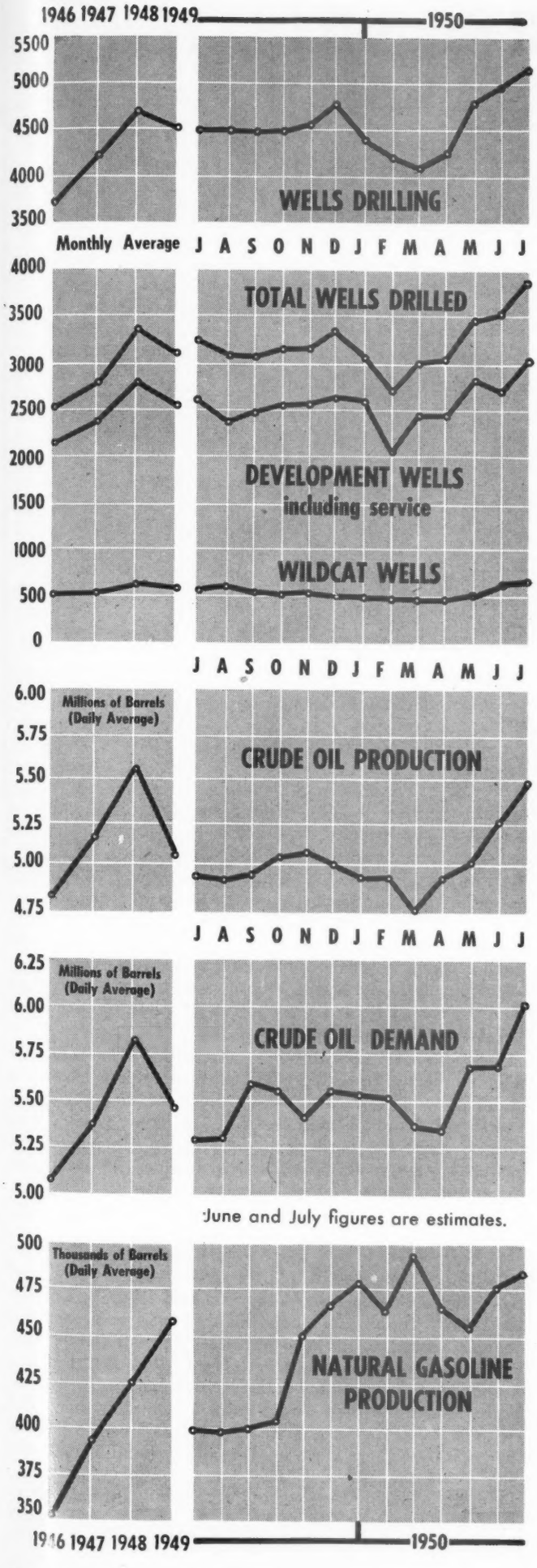
▸ **Fuels Study.** Coal-state senators are still hopeful of putting over the Myers Resolution for a study of coal, oil, gas, and other fuels to develop a national policy on fuels and their uses.

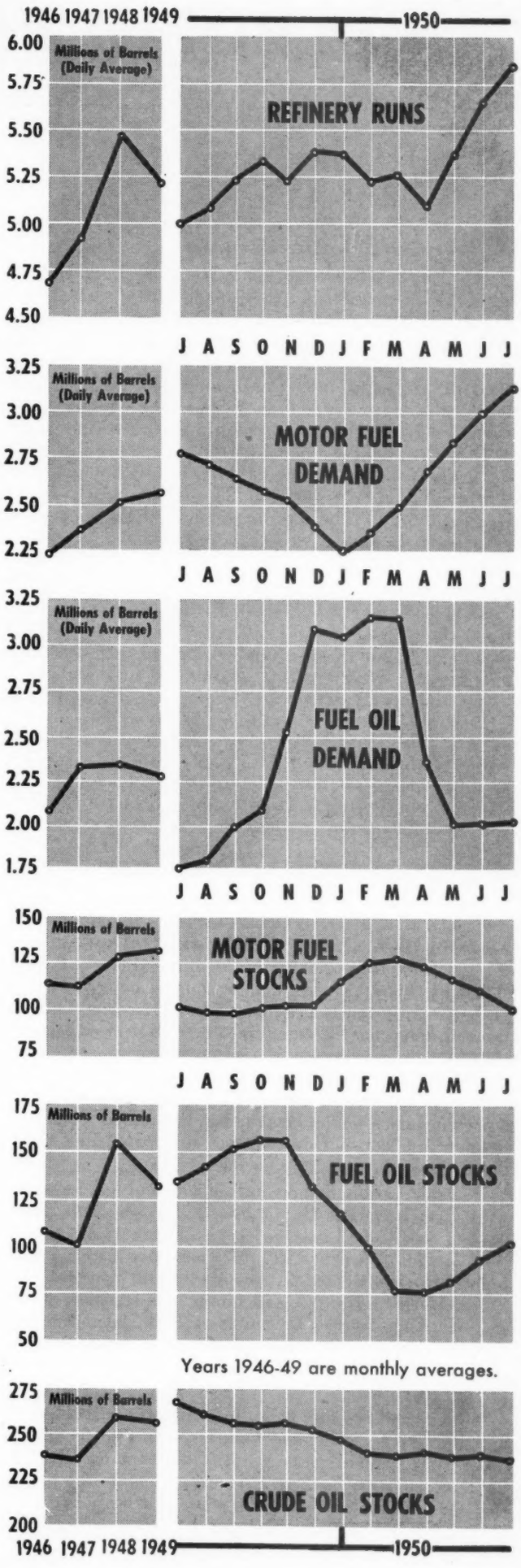
The Senate Interior Committee, which would make the study, say it "will result in many needed legislative recommendations." This tends to confirm the fears of the petroleum industry, which has apprehensions that such recommendations might include "end use" controls for oil and gas as well as other restrictions intended to promote the consumption of coal.

Meanwhile, Senator Thomas of Oklahoma stands like Horatius, having blocked adoption of the resolution once by a parliamentary maneuver after the Senate had voted in favor of it.

▸ **Tax Bill.** Disgruntled coal-state senators may propose that the Senate restore the increase—from 5 to 10 per cent—in the coal depletion allowance and roll back the oil-gas depletion allowance—but they won't get anywhere with this idea at this session. The tax bill, as it goes to the White House, likely will be much the same as the measure reported by the Senate Finance Committee.

▸ **Renegotiation.** The Ways and Means Committee has apparently shelved, for the present, the war contract renegotiation bill, which would *not* exempt oil, gas, and other raw materials, thus laying open to possible reduction the crude prices paid by refiners making military products. Oil witnesses made a good case—but there were some committee members still unconvinced, mostly those who are critics of the depletion allowance.


1946 1947 1948 1949
1950
WELLS DRILLING
Monthly Average
J A S O N D J F M A M J J
TOTAL WELLS DRILLED
DEVELOPMENT WELLS
including service
WILDCAT WELLS
CRUDE OIL PRODUCTION
Millions of Barrels
(Daily Average)
CRUDE OIL DEMAND
June and July figures are estimates.
Thousands of Barrels
(Daily Average)
NATURAL GASOLINE
PRODUCTION


1946 1947 1948 1949
1950
REFINERY RUNS
Millions of Barrels
(Daily Average)
J A S O N D J F M A M J J
MOTOR FUEL
DEMAND
FUEL OIL
DEMAND
MOTOR FUEL
STOCKS
FUEL OIL STOCKS
Years 1946-49 are monthly averages.
CRUDE OIL STOCKS

PETROLIC PERSONALITIES

DICK SNEDDON

A Houston Home-Coming

There will shortly charge into Houston, Texas, intent on taking up residence there, after an absence of some 21 years, that dreadnaught of the night clubs and rathskellers, Alvin "Dutch" Zwerneman. Los Angeles is going to look pretty empty to a lot of people when Dutch pulls out. He has brightened the Jonathan and Petroleum Clubs in the western metropolis for many a day; he has long contributed substantially to the better life, ladeling out titivating libations at PPP parties; and for the past 14 years more or less, on the third Friday of each month, has lashed some portion of the Pacific landscape in a futile effort to win one of the Nineteener's golf trophies. His golf unfortunately never quite got down into the rarefied atmosphere of the seventies and the bauble remained just beyond his reach. But by another route he won his trophy anyway.

At a recent party in the Jonathan Club, hosted by Hans Ross, and emceed by Bill Farrar, the Nineteeners turned out in force to honor Dutch. He was eulogized to the seven signs and wished everything that is good by Jock McLeod, the Caledonian prexy of Macco Corporation. Hans Ross likewise extolled the Zwerneman virtues in a flattering bit of oratory. And Joe Aderhold, erstwhile partner in the Allied Supply Company wound up a well delivered surge of congratulatory eloquence by presenting Dutch with one of the elusive golf trophies—for just being a good fellow.

Zwerneman Discovers America

For the benefit of the good people of Houston, it might be remarked that the Zwerneman invasion is actually in the nature of a home-coming. Dutch caught his first glimpse of this wicked old world in the hustling village of Bartlett, Williams County, Texas, and as soon as he could walk migrated to Houston to get himself an education. Then came the war deferring his entry into the oil business for several years. There are ill dispositioned persons who claim it was the Civil War, but that should certainly be taken *cum grano salis* as it says in our dictionary of Latin phrases. Anyway, when the young soldier came home, he found a job with Gulf Corporation out of Houston, and since that time has been more places than a tramp steamer.

He later garnered more oil experience and more travel with Arkansas Fuel Oil Company, for which he galloped around Arkansas, Lousiana, Texas, Oklahoma, Kansas and New Mexico. Then in 1927, he was taken over by Axelson Manufacturing Company, saw service in Houston, Dallas, Tulsa, Wichita, Kansas, and finally was transferred to Los Angeles. That covered 31 years ago. In the meantime he had become vice president and general sales manager of Axelson and about as well and favorably known as anyone in the industry.

He resigned recently to go into business for himself as a manufacturers' agent, and naturally chose to forage in his home state, which offers a fertile field for exercise of the unbounded Zwerneman zest. There are many who are wishing him well in this new enterprise, and we personally are pulling like nobody's business for the success of the Zwerneman enterprises whatever they may be.

Vic Lemay Adds to His Laurels

Space limitations in the July issue precluded the completion of our story on the Dallas-Fort Worth Nomads whing ding, which we continue here and now:

As usual, Fireball Courtney Berlin of Baker Oil Tools was greatly in evidence and did much to add to the general enjoyment. Also instrumental in keeping the decibel output from shattering the mirrors was Johnny Everroad, another Cummins product, and a master arranger of high class entertainment. Johnny is sergeant-at-arms of the chapter, and he dished up for this occasion as nice a schedule of diverting events as one could well wish to see. But the man who really wore the seven league boots was Vic LeMay, the tall handsome Mid-Continent lad, with the fine personality and friendly manner. Vic and his camera were everywhere always, helping no end to really make the whole affair a pronounced success. Incidentally, noted among the spectators who cheered the golfers on to more violent lashing of the areas immediately surrounding their golf balls, were George Dehn of Magnaflux and Chester Wimberly of Halliburton.

Missouri Hibernian on Texas Rampage

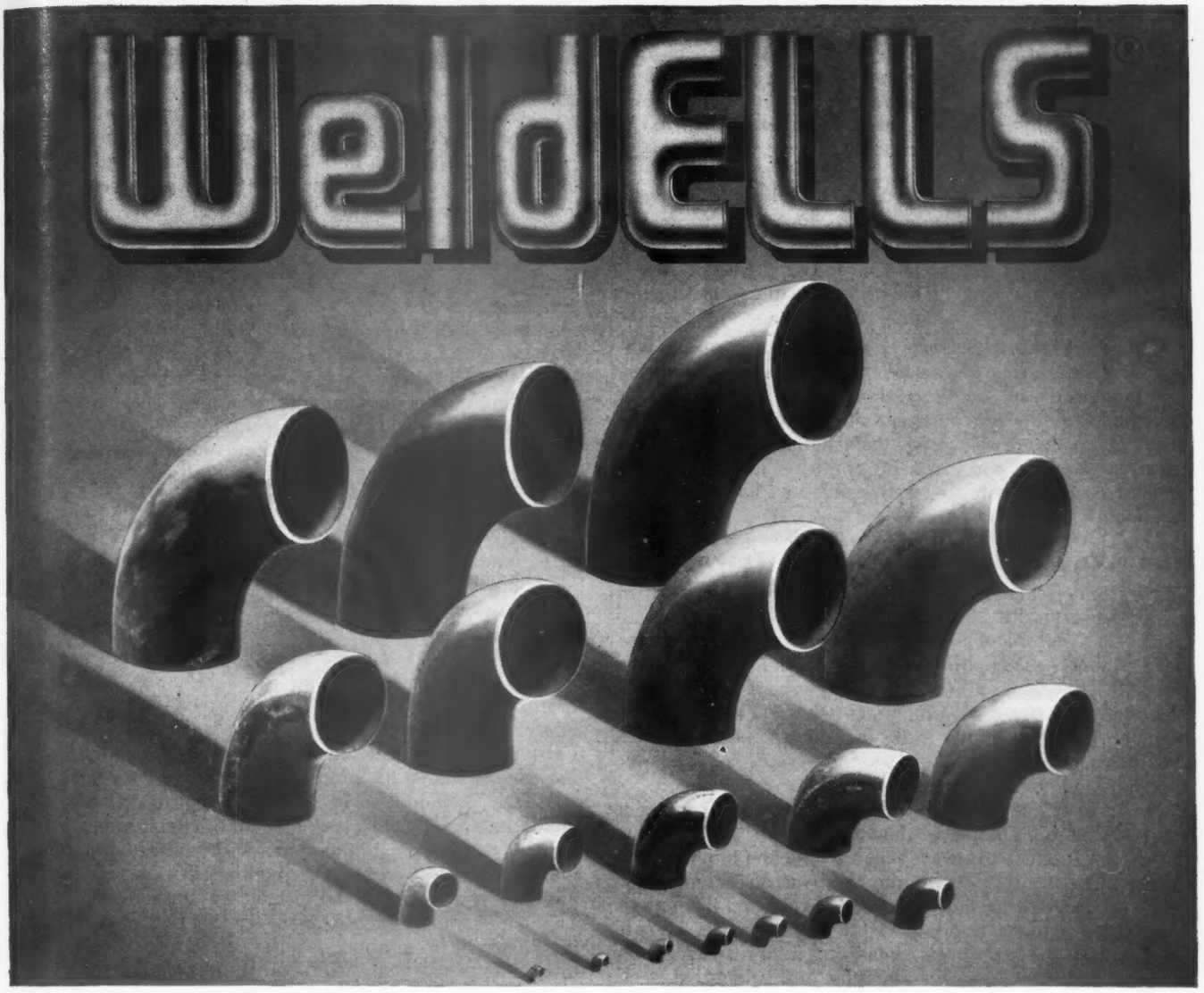
The rumor that Texas had recently been the victim of a terrific cyclone was later traced to the whirlwind passage through the Lone Star State of a diminutive but decidedly volcanic lubrication engineer from Missouri, by the name of S. M. "Cy" McKee. This abbreviated Hibernian is a highly regarded attache of the Nourse Oil Company, and has his headquarters in Kansas City, but in that respect he is neither an immovable body nor an irresistible force. On the contrary, he moves with little compunction and on little notice, and he can't resist the urge to travel when the time and the occasion are right. A late communique states that he has just completed a month of one-night stands in Texas, during which he drove some 4000 miles, met the grandest lot of people in the world, saw more of the State than have 95 per cent of its natives, and at the time he wrote was streaking out toward Old Mexico.

This 1950 Lemuel Gulliver is a ballistics whiz, being particularly partial to scatter guns, and his favorite pastime is knocking over a brace or two of pheasants in the Dakotas, which he has done very successfully for many years, we are told. It really has nothing to do with the subject, but you can always tell an Irishman in a card game—he never picks up a club without first spitting on his hands.

Gondoliers and Barcaroles

We have just received a "hello, wisht you was here" card from that estimable son of the Emerald Isle, Tom Hickey, the Hickey Supply Co.'s good looking head man, who is at present sashaying around Europe and apparently thoroughly enjoying the experience. The card is datelined from *Roma*, which we presume is the way the Italians spell Rome. You would think they would know better after living in it all their lives. Anyway, Tom figures that business can't be too good over there because some of the buildings are over 2000 years old.

And there are indications, too, that some of the people are not too ambitious. The streets of Venice are still flooded and nobody seems to be the least bit concerned. The folks



Family Group . . . *proud of its size . . . and traditions*

Large group though it is, you see here only one branch of the world's largest family of fittings for pipe welding.

It is simply the stock sizes of long-radius WeldELLS in a single weight and material — merely a small fraction of the enormous line that includes more types of fittings, in more materials, more weights and more sizes than any other line.

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sail up and down these submerged boulevards in gondolas, and when the traffic gets heavy, they don't cuss each other out as we do here, they just keep on singing a barcarole. In fact, that's how you tell a native from a foreigner in Venice —if he isn't singing a barcarole he is probably from the Bronx. Continuing the narrative, however, Tom was intrigued no end with the city of Lisbon in Portugal, which he thought was almost beautiful enough to be moved over to Ireland. And the impregnable Gibraltar with its maze of underground passages and hidden fortifications, stirred up memories of great battles and unprepared history lessons. As Junior always said, "I hate battles—they make history, and I hate history!"

That's all from the Hickeys now, but we hope to have some really exciting news when they land on the Ould Sod. We fancy we can see them standing there twirling their shillelaghs as the mavourneens and spalpeens dance Irish jigs around them, welcoming them home with joyous cries of "Arrogowan!" and "Erin go bragh!" "Erin go bragh!" of course, means erin go—well, erin—aw, heck, why don't you look it up yourself.

The Ways of a Man About Town

For some years now we have worked in comparatively close consort with that distinguished looking chap, Joe Siegel of Kobe, Incorporated, who seems to know so many head waiters, maitre de's, and reservation (Not Indian) bigshots, that while all the rest of the world is scrambling frantically but fruitlessly for seats—theater, plane, train—or hotel rooms, he simply walks in, takes the best seat or the best room, and everybody bows and scrapes as if he were the Akhoond of Swat.

We have studied the methods of this debonair lad most minutely, and, thinking we had the system down pat, we have tried it out, but always when we tilt the old proboscis and demand the royal suite, the clerk merely summons the house dick and we are hustled out the back way, through the laundry, to avoid a scandal. As for theater tickets we can't get reservations six weeks ahead for a Main Street burlesque, but Joe walks in on Thursday and gets a seat in the front row at South Pacific for Friday. S'most humiliating! We have found out one of his secrets though: When he is after something big, he goes for the big guy. We have always on the contrary worked from the janitor up and as a result have seldom got past the night watchman.

And then, of course, Joe is a pretty smooth looking chap with his silver tipped hair and his California tan.

Pancho Villa Meets His Match

When he goes into one of these big cafes and stalks majestically past the waiting line, you should see the blonde who shows the people to their seats fall over her shoelaces as she rushes to find him a place by the window. There are few people so well known in the better San Francisco and Los Angeles hotels and night spots as Joe, and we know whereof we speak. It isn't the first time we have snaffled a swell room in a busy time by telling the room clerk, "It's for Mr. Siegel—he'll be along later." Joe is originally a product of Ithaca, New York but came out to California before he had even learned to speak nasally. About 30 years ago plus or minus he ran into C. J. "Kobe" Coberly out in Los Angeles, and has been associated with him ever since. One of his most exciting adventures took place in Tampico, Mexico, where he was lodged—probably in the royal suite —while Pancho Villa was on his notorious rampage. It is reported that when he and Pancho met on Main Street one day, the two looked unwaveringly into each other's eyes, and the crowd dived for cover. When the smoke of the six guns had cleared, Pancho was found to be the casualty—Joe had sold him a load of slotted pipe.

Mens Sana in Corpore Sand

Rapidly building a national reputation, and it couldn't happen to a nicer fella, is Johnny Sherborne, the clean cut little chap who functions for Union Oil Company as assistant to the vice president in charge of research. Johnny is as neat as the proverbial pin both in his appearance and his thinking. We fancy he is the kind of a chap who is very methodical—inclined to keep his work up to date; his correspondence not hidden in the lower left hand drawer, but disposed of properly; and his mind clear of any mental hangover. We don't mean to indicate that all the time he is all business. Far be it from such. As a matter of fact, we have had occasion to be with Johnny in places where oil men were making wassail, and we can assure our readers that the lad was no quaking wall flower. On the contrary, he wore a paper hat as becomingly as anyone, and his singing was certainly not the reluctant bleat of an introvert. No, sir, it was loud and strong—perhaps even a bit off key—but, by george, it was a manly voice.

Highlights in the Sherborne Saga

To continue, however, Johnny is a native of Leeds, England, but he left the Yorkshire city some thirty years ago and struck out for Long Beach, California. He attended school there, became an American citizen, dropped his Yorkshire accent and stopped dropping his aitches. Then he attended California Institute of Technology, whence he graduated in 1934 with a B.Sc. degree. Later he took his masters in petroleum engineering at University of Southern California, and in the meantime has by application and experience extended his education no end.

He has done oodles of research in the production of petroleum; has conducted classes in petroleum production and reservoir engineering at university; has been national chairman of several important API committees; and is at present national chairman of the petroleum branch of AIMME. That's no small accomplishment for just one small man, but the beautiful thing about it all is that the small man seems to be able to take care of his multitudinous responsibilities without ever losing stride. He always has the glow of a real health in his skin and a friendliness in his demeanor that show very plainly he is not entertaining ulcers. In all respects, indeed, he is a personable, likable individual—accomplished, easy to know, and withal worth knowing.

Ventura Short Order Cook in Europe

A recent call at the office of Fritz Huntsinger, the Ventura short order cook, elicited the information that he, too, is skirmishing around Europe. There seems to be a regular epidemic of that sort of thing right now. Fritz is the president of Ventura Tool Company, and a highly respected citizen of the mission city. He is every bit as much an artist with a mixing spoon and a few condiment cans as is any Salvador Dali with a camel hair brush and a palette. And what he can do to the most common dishes is the sort of thing that makes a man turn gourmet. As we understand it, his interest in the barbecuing business began when it suddenly occurred to him one day that the taste of ordinary table salt could be tremendously improved by the addition of some hamburger steak. He tried his idea out, and Eureka or something—it worked! Ever since that day, he has spent a large portion of his waking moments working over hot plates, grills, and things, concocting the most delectable dishes you ever sniffed. Fritz is just as inventive in the compounding and treatment of new dishes as he is in the fabricating of a new oil tool, and the products of his culinary wizardry are widely favored. One of the really staunch admirers of Fritz's kitchen kraft is Governor Warren, who steps by occasionally for tidbit off the Huntsinger grill.

NATURAL GASOLINE PRODUCED IN THE UNITED STATES BY STATES, 1911-1947

(Thousands of Gallons)

Year	Arkansas	California	Colorado	Illinois	Kansas	Kentucky	Louisiana	Michigan	Montana	N. Mexico
1911		*	*	*		*				
1912		1,041	*	*		*				
1913		3,461	*	*	*	*				
1914		7,581	*	1,164	*	*				
1915		12,835	*	1,035	*	*	*			
1916		17,159	*	2,260	215	725	2,113			
1917		28,818	*	4,934	1,175	3,818	4,980			
1918		32,269	2	4,575	2,390	3,331	7,021			
1919		40,386	0	6,060	3,284	5,136	10,063			
1920		48,208	0	6,055	4,331	4,497	10,610			
1921		58,220	0	7,536	3,587	4,242	15,341			
1922	4,289	67,120	0	7,760	2,856	5,205	29,406			
1923	16,183	173,329	0	7,356	8,775	7,601	40,720			
1924	17,533	232,579	0	9,091	11,658	7,274	48,098			
1925	19,686	303,180	35	9,874	19,592	7,685	43,489			
1926	30,385	389,366	276	9,987	25,369	7,689	43,557			1,488
1927	37,498	498,020	912	8,853	36,095	7,480	44,844			1,827
1928	32,677	584,111	1,909	7,817	36,765	7,267	55,022			1,506
1929	33,455	840,325	1,630	7,080	36,227	6,006	64,957			1,077
1930	30,637	829,713	1,322	6,867	35,106	6,641	73,693			3,663
1931	26,282	680,339	659	5,024	32,690	5,464	58,034			17,775
1932	18,653	551,897	472	4,558	24,792	4,877	46,199			17,507
1933	15,215	496,293	408	3,673	24,869	4,514	36,973	188	1,295	19,149
1934	13,033	506,272	643	3,810	27,891	4,171	40,558	589	1,237	21,748
1935	13,076	534,624	417	2,642	32,507	5,614	49,732	1,850	1,739	19,563
1936	11,957	593,416	451	2,337	37,775	6,009	72,687	2,015	2,071	28,921
1937	11,285	623,894	404	2,567	57,026	7,344	106,415	2,408	2,296	38,253
1938	25,648	660,890	386	2,436	55,988	7,040	95,634	3,581	1,768	49,596
1939	24,634	607,237	390	4,012	62,175	7,785	94,090	2,971	2,161	54,707
1940	32,096	587,476	380	21,499	64,691	9,539	113,741	3,919	2,603	55,713
1941†	34,389	659,765	390	93,165	85,691	35,371	225,724	5,670	3,966	81,000
1942	42,677	633,326	346	139,323	81,828	36,682	296,074	2,518	4,517	89,164
1943	56,837	693,332	468	185,487	85,206	43,317	306,062	1,226	4,664	81,005
1944	75,536	771,280	⊕	194,369	69,834	48,742	492,659	8,500	4,768	81,161
1945	85,941	891,753	⊕	175,992	72,637	46,879	549,234	13,630	4,726	97,800
1946	84,507	910,538	840	161,560	82,591	53,862	566,796	12,337	4,597	103,642
1947 ℗	93,202	1,070,859	⊕	162,923	100,195	60,191	630,319	4,268	5,627	113,893

Year	New York	Ohio	Oklahoma	Penn-sylvania	Texas	West Virginia	Wyoming	Others	Total U. S.	Value at plants	
										Thousand dollars	Avg per gal cents
1911	*	1,679	388	1,467		3,660		232	7,426	532	7:2
1912	*	1,719	1,575	2,041		5,318		387	12,081	1,157	9.6
1913	*	2,073	6,463	3,680		7,662		722	24,061	2,458	10.2
1914	*	2,440	17,278	4,612		9,278		300	42,653	3,106	7.3
1915	*	2,199	31,666	5,899	*	10,854		877	65,365	5,151	7.9
1916	*	2,639	48,360	9,715	1,293	18,765		240	103,493	14,331	13.8
1917	*	5,440	115,123	13,826	6,920	32,669		181	217,884	40,189	18.4
1918	218	6,745	163,701	15,775	7,326	37,604	1,579	0	282,536	50,364	17.8
1919	458	8,801	189,995	20,284	9,337	52,150	5,581	0	351,535	64,197	18.3
1920	411	10,016	178,857	21,151	32,956	58,941	8,711	0	384,744	71,788	18.7
1921	366	9,100	185,341	19,856	77,141	54,646	14,558	0	449,934	61,815	13.7
1922	506	8,600	189,404	18,518	95,405	56,796	19,967	0	505,832	72,711	14.4
1923	408	10,035	270,249	19,132	177,765	63,381	21,292	0	816,226	77,268	9.5
1924	477	9,443	301,062	19,254	186,571	61,549	29,272	0	933,861	82,233	8.8
1925	414	8,701	390,861	18,850	214,092	58,201	32,777	33	1,127,470	120,383	10.7
1926	539	10,817	475,716	20,343	243,093	63,807	40,625	33	1,363,090	136,412	10.0
1927	449	12,167	548,109	16,744	320,723	64,192	43,212	19	1,641,144	118,688	7.2
1928	392	13,174	619,691	16,571	324,516	69,729	42,861	26	1,814,034	138,944	7.7
1929	264	11,166	676,030	18,411	419,485	72,994	44,544	37	2,233,688	158,410	7.1
1930	208	8,937	591,194	16,713	491,299	63,328	51,132	41	2,210,494	128,160	5.8
1931	132	5,199	454,886	14,339	426,695	52,844	51,523	33	1,831,918	63,732	3.5
1932	117	5,163	378,584	11,685	371,106	43,773	44,391	26	1,523,800	49,244	3.2
1933	96	4,662	360,488	11,686	366,515	39,848	34,103	25	1,420,000	54,368	3.8
1934	85	5,881	355,438	10,781	466,570	41,854	34,799	0	1,535,360	60,523	3.9
1935	27	6,232	379,913	12,623	516,748	42,433	32,246	0	1,651,986	70,940	4.3
1936	22	6,991	418,591	14,267	520,547	44,389	33,894	0	1,796,340	84,572	4.7
1937	33	7,704	492,290	13,940	615,281	50,379	33,915	0	2,065,434	97,125	4.7
1938	27	7,382	468,499	10,734	685,920	50,398	30,647	0	2,156,574	87,266	4.0
1939	34	7,445	436,123	11,756	770,047	52,272	31,461	0	2,169,300	90,050	4.2
1940	17	8,062	399,369	15,371	932,040	58,782	34,102	0	2,339,400	68,261	2.9
1941†	17	8,217	453,383	16,011	1,558,819	98,044	35,480	808‡	3,395,910	119,120	3.5
1942	15	6,975	445,115	15,294	1,567,830	101,828	35,237	775‡	3,499,524	121,565	3.5
1943	12	6,495	422,313	17,534	1,646,031	97,942	35,475	666‡	3,684,072	146,910	4.0
1944	12	7,282	421,768	17,495	1,870,419	88,917	49,190⊕	⊕	4,201,932	182,500	4.3
1945	8	6,452	416,184	14,181	2,188,305	87,609	52,842⊕	⊕	4,704,173	187,564	4.0
1946	9	6,253	414,991	11,003	2,282,979	120,444	43,506	578‡	4,861,033	179,990	3.7
1947 ℗	10	7,131	445,923	13,172	2,619,930	146,838	52,450⊕	17,113△	5,544,044	—	—

*Included with "Others".
†Beginning with 1941 includes cycle products and liquefied petroleum gases.
‡Utah △Mississippi. ⊕Drip Gasoline produced in Colorado and Utah included with Wyoming.
Source: U. S. Bureau of Mines. ℗Preliminary

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

UNITED STATES LUBRICATING OIL SUPPLY AND DEMAND

(Thousands of Barrels)

Year	Supply				Demand			Stocks		Supply per cent of demand	Days of supply+
	Production from crude (1)	Per cent yield (2)	Imports (3)	Total supply (4)	Indicated domestic consumption (5)	Exports (6)	Total demand (7)	Closing stocks (8)	Increase—decrease in stocks (9)	(10)	(11)
1918	20,035	6.15		20,035	13,822	6,165	19,987	3,306	+ 48	100	60*
1919	20,161	5.58		20,161	13,600	6 598	20,198	3,269	— 37	100	49*
1920	24,938	5.75		24,938	14,742	9,643	24,385	3,822	+ 553	102	74*
1921	20,896	4.71		20,896	12,047	6,936	18,983	5,735	+1,913	110	89*
1922	23,304	4.65	†	23,304	15,485	7,941	23,426	5,613	— 122	99	79*
1923	26,128	4.50	29	26,157	17,617	8,372	25,989	5,781‡	+ 168	101	83
1924	27,498	4.27	11	27,509	18,124	9,103	27,227	6,420	+ 282	101	84
1925	31,055	4.20	37	31,092	20,581	9,678	30,259	7,253	+ 833	103	89
1926	32,293	4.14	33	32,326	22,568	9,435	32,003	7,576	+ 323	101	95
1927	31,721	3.83	8	31,729	21,669	9,776	31,445	7,860	+ 284	101	92
1928	34,658	3.79	13	34,671	23,168	11,023	34,191	8,340	+ 480	101	95
1929	34,359	3.48	39	34,398	23,609	10,860	34,469	8,269	— 71	100	100
1930	34,201	3.69	25	34,226	21,589	9,935	31,524	10,971○	+2,702	109	134
1931	26,704	3.09	32	26,736	19,924	8,128	28,052	9,511⊕	—1,316	95	135
1932	22,433	2.74	12	22,445	16,614	6,851	23,465	8,465⊙	—1,020	96	139
1933	23,775	2.76	1	23,776	17,152	8,218	25,370	7,100	—1,594	94	100
1934	26,373	2.94	2	26,375	18,484	7,660	26,144	7,331	+ 231	101	101
1935	27,853	2.88	1	27,854	19,661	8,499	28,160	7,025	— 306	99	92
1936	30,927	2.89	4	30,931	22,323	8,691	31,014	6,942□	— 83	100	78
1937	35,321	2.98	7	35,328	23,323	10,975	34,298	7,512	+1,030	103	93
1938	30,826	2.65	7	30,833	21,233	9,417	30,650	7,695	+ 183	101	91
1939	35,036	2.83	5	35,041	23,713	11,881	35,594	7,142	— 553	98	74
1940	36,765	2.84	11	36,776	24,690	10,461	35,151	8,767	+1,625	105	94
1941	39,539	2.81	0	39,539	30,255	9,924	40,179	8,127	— 640	98	74
1942	38,626	2.90	0	38,626	29,057	8,272	37,329	9,424	+1,297	103	98
1943	38,679	2.71	0	38,679	31,459	8,863	40,322	7,781	—1,643	96	73
1944	41,106	2.47	0	41,106	32,363	8,709	41,072	7,815	+ 34	100	68
1945	41,867	2.43	0	41,867	35,334	6,575	41,909	7,773	— 42	100	72
1946	45,645	2.64	88	45,733	34,891	11,051	45,942	7,564	— 209	100	56
1947 Ⓟ	51,765	2.79	44	51,809	36,513	14,236	50,749	8,624	+1,060	102	59

† Imports information not available prior to October, 1922.

Ⓟ Preliminary.

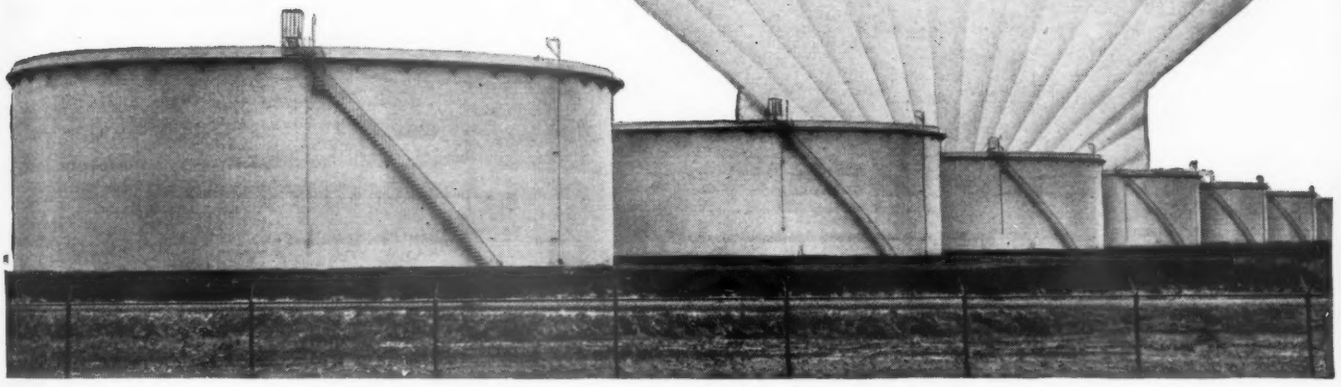
Comparable with subsequent periods: ‡6,138; ○10,827; ⊕9,485; ⊙8,694; □6,482.

+ Based on average daily demand for like period of time immediately following except those marked with asterisk; these based on average daily demand for succeeding year.

Source: American Petroleum Institute "Statistical Bulletin"; U.S. Bureau of Mines.

GRAVER FLOATING ROOF TANKS

at SHELL's WOOD RIVER TANK FARM

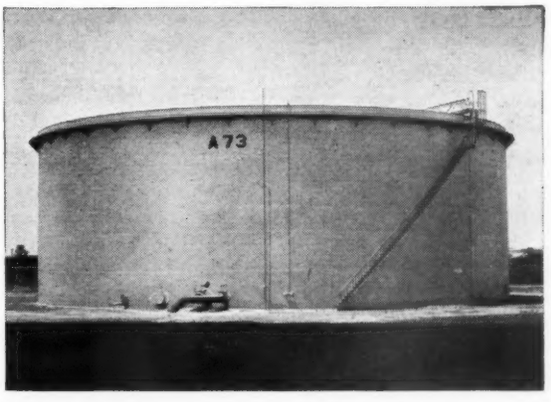


Serving the largest American crude oil pipe line ever built by private capital

To receive the river of crude oil flowing from the mighty Basin-Ozark pipe line system, Shell has completed the Southwest Tank Farm at its Wood River Refinery.

Sprawling over 190 acres of land, this tank farm has an aggregate capacity of approximately two and one-half million barrels, involving the use of 11 Graver Double Deck Floating Roof Tanks—140 feet in diameter, 48 feet high—each with a nominal capacity of 127,000 barrels.

Thus, Graver shares in the substantial progress of the Shell Oil Company in providing facilities for reducing operating expenses and achieving greater efficiency in the handling of crudes.



One of the 11 Graver Floating Roof Tanks at Wood River. All are Double Deck Construction with the fully effective *single* Graver Seal.

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

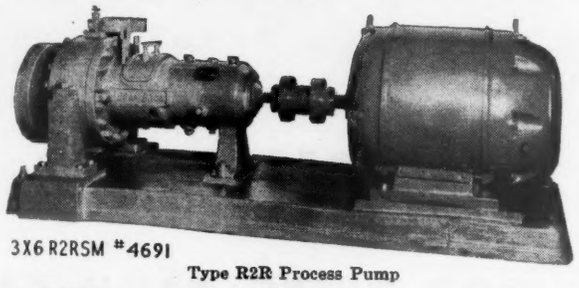
GRAVER

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

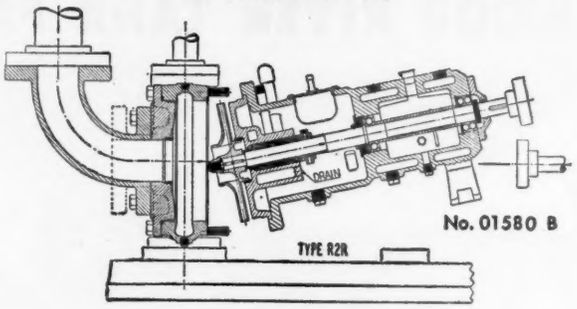
Source: American Petroleum Institute "Statistical Bulletin"; U.S. Bureau of Mines.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

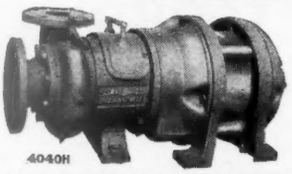
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

Capacities: 50 to 2000 Gallons per minute. **Heads:** Up to 400'. **Speeds:** 900 RPM to 4000 RPM.

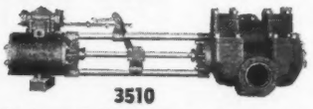
BUILDERS OF OUTSTANDING PUMPS

SINCE 1869

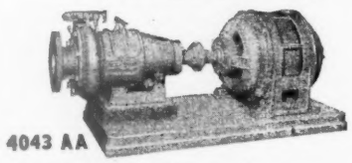
CENTRIFUGAL and RECIPROCATING PUMPS



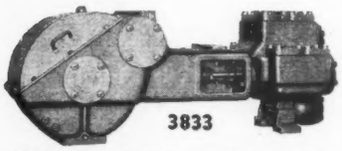
Close Coupled Centrifugal Pump



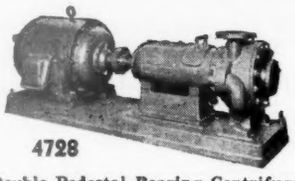
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



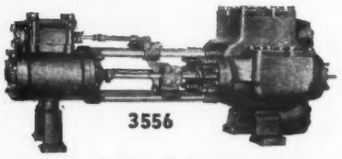
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



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Sept. 3-8—American Chemical Society, Chicago, Illinois.

Sept. 5-9—National Chemical Exposition, Chicago Section, American Chemical Soc., Coliseum, Chicago, Ill.

Sept. 10-13—The American Institute of Chemical Engineers, Regional Meeting, Radisson Hotel, Minneapolis, Minnesota.

Sept. 11-13—International Discussion, Postwar Heat Transfer Development, London, England. Participants from North America include: AIChE, ACS, AIME, ASME, etc.

Sept. 11-13—Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 11-15—ASME Industrial Instruments and Regulators Conference with the Instrument Society of America, Municipal Auditorium, Buffalo, New York.

Sept. 13-15—National Petroleum Assn, Hotel Traymore, Atlantic City, N. J.

Sept. 14—API, Lubrication Committee, Hotel Traymore, Atlantic City, N. J.

Sept. 14-15—Midwest Gas Assn, Gas School and Conference, Ames, Iowa.

Sept. 18-19—Natural Butane-Propane Assn, Annual Convention, Hollenden Hotel, Cleveland, Ohio.

Sept. 18-22—Instrument Conference and Exhibit, Instrument Society of America, Memorial Auditorium, Buffalo, New York.

Sept. 22—Gas Division—Oklahoma Utilities Association, Biltmore Hotel, Oklahoma City, Okla.

Sept. 24-28—ASME Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.

Sept. 25-27—ASME, Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.

Oct. 1-3—IPAA, Annual Meeting, Jefferson Hotel, St. Louis, Mo.

Oct. 2-6—AGA, Annual Convention, Atlantic City, New Jersey.

Oct. 4-5—Mid-Continent Oil and Gas Assn, Texas Division, Baker Hotel (tentative), Dallas, Texas.

Oct. 4-6—AIME, Petroleum Branch, Fall Mid-Continent Meeting, Roosevelt Hotel, New Orleans, La.

Oct. 5-6—Liquefied Petroleum Gas Assn, North Eastern District Meeting, Ambassador Hotel, Atlantic City, N. J.

Oct. 9-10—American Assn of Oilwell Drilling Contractors, Annual Meeting, The Mayo, Tulsa, Okla.

Oct. 12-13—AIME, Petroleum Branch, Fall West Coast Meeting, Elks Club, Los Angeles, Calif.

Oct. 15-21—OIL PROGRESS WEEK.

Oct. 16-20—National Safety Congress, Chicago, Ill.

Oct. 18-19—National Conference, Industrial Hydraulics, Sherman Hotel, Chicago, Illinois.

Oct. 19-20—American Assn of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, and Society of Exploration Geophysicists, all Pacific Coast Sections, Ambassador Hotel, Los Angeles, Calif.

Oct. 19-22—Permian Basin Oil Show, Odessa, Texas.

Oct. 23—Independent Natural Gas Association of America, Annual Meeting, Shamrock Hotel, Houston, Texas.

Oct. 23-27—AIEE, Fall General Meeting, Skirvin Hotel and Skirvin Tower Hotel, Oklahoma City, Okla.

Oct. 23-27—National Metal Exposition, Amphitheater, Chicago, Ill.

Oct. 27—Natural Gasoline Association of America Southern Regional Meeting, Blackstone Hotel, Tyler, Texas.

Oct. 30-Nov. 1—National Lubricating Grease Institute, Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

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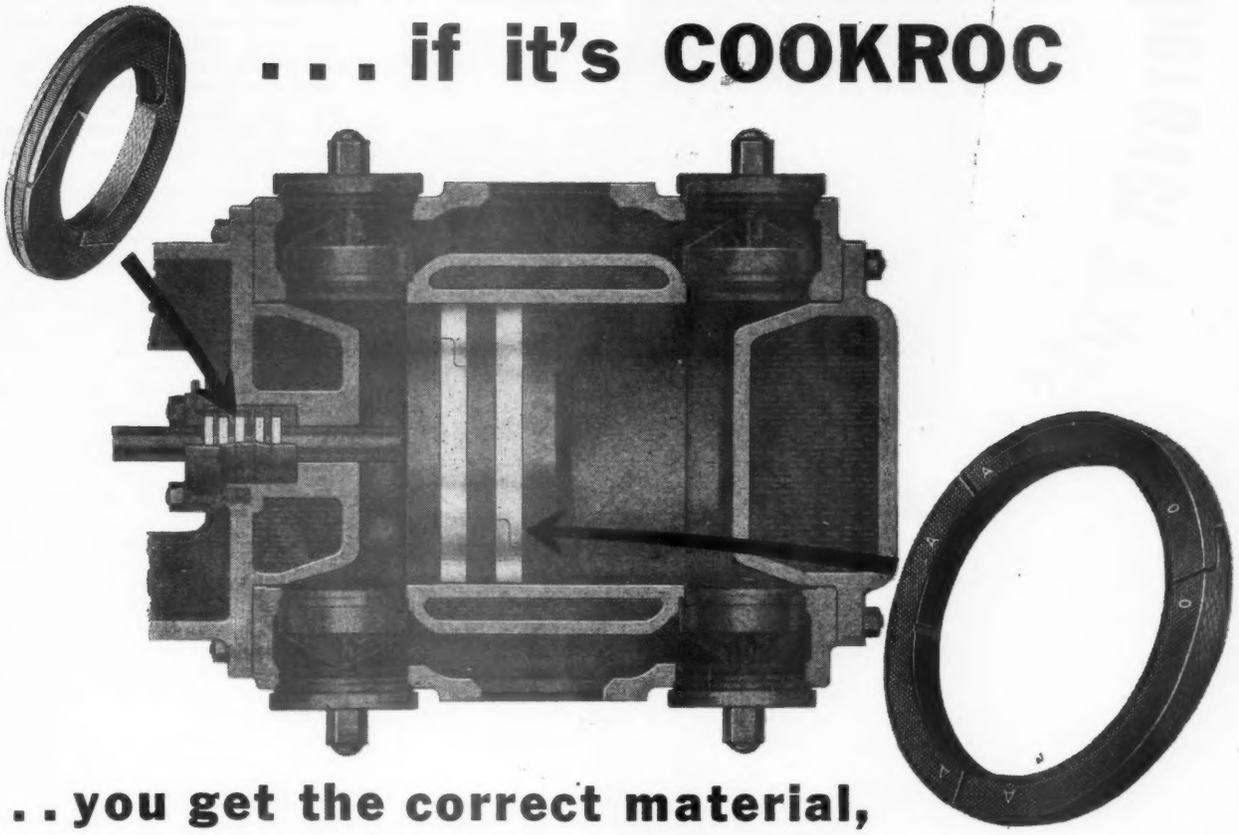

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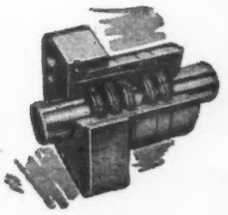

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Nov.—Mid-Continent Oil and Gas Assn, Mississippi-Alabama Division, Edwards Hotel (tentative), Jackson, Miss.

Nov.—Mid-Continent Oil and Gas Assn, Kansas-Oklahoma Division, Tulsa Club (tentative), Tulsa, Okla.

Nov. 2-3—Mid-Continent Oil and Gas Association, Louisiana-Arkansas Division, Roosevelt Hotel, New Orleans, La.

Nov. 2-3—Society of Automotive Engineers, Diesel Engine Meeting, Hotel Knickerbocker, Chicago, Ill.

Nov. 9-10—SAE, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

Nov. 9-10—California Natural Gasoline Assn, Annual Meeting, Ambassador Hotel, Los Angeles, Calif.

Nov. 11-13—Oil Industry Information Committee, Biltmore Hotel, Los Angeles, Calif.

No. 13-14—API, Lubrication Committee, Biltmore Hotel, Los Angeles, Calif.

Nov. 13-16—API, Annual Meeting, Biltmore Hotel and Ambassador Hotel, Los Angeles, Calif.

Nov. 26-Dec. 1—ASME, Hotel Statler, New York, N. Y.

Dec. 3-6—AIChE, Annual Meeting, Columbus, Ohio.

Dec. 26-31—American Assn for the Advancement of Science, Annual Meeting, Hotel Statler, Cleveland, Ohio.

1951

Jan. 9-10—Pipe Line Contractors Association, Shamrock Hotel, Houston, Texas.

March 7-9—API Division of Production, Southwestern District Meeting, Hotel Beaumont, Beaumont, Texas.

March 16-18—American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Bellevue-Stratford Hotel, Philadelphia, Pa.

March 21-23—API, Mid-Continent District, Herring Hotel, Amarillo, Texas.

March 23-25—Southern Gas Association, Buena Vista and Edgewater Gulf Hotels, Biloxi, Miss.

April 2-4—Western Petroleum Refiners Association, Annual Meeting, Plaza Hotel, San Antonio, Texas.

April 3-5—API, Eastern District, Deshler-Wallick Hotel, Columbus, Ohio.

April 18-20—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.

May 10-11—API Pacific Coast District, Biltmore Hotel, Los Angeles, Calif.

May 13-16—AIChE, Regional Meeting, Hotel Muehlebach, Kansas City, Mo.

May 28-June 6—World Petroleum Congress, The Netherlands, The Hague.

June 16-20—Canadian Gas Assn, Bigwin Inn, Lake of Bays, Ontario, Canada.

Oct. 15-20—Oil Progress Week.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Sec. Russ V. McIntire, 11 West 42nd Street, New York 18, New York.

Houston Chapter, Second Monday of the Month, Ye Ole College Inn, Houston, Texas. Sec. Harry E. Estes, P. O. Box 9321, Houston 11, Texas.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Sec. John W. Rife, 5905 Pacific Blvd., Huntington Park, Calif.

Tulsa Chapter, Third Wednesday of the Month, Hotel Tulsa, Tulsa, Okla. Sec. G. W. Davidson, Jr., Box 1188, Tulsa, Okla.

Dallas Chapter, Dallas, Texas, First Monday of the Month. Sec. C. J. Berlin, P. O. Box 2968, Dallas, Texas.

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LETTERS TO THE EDITORS

Questions Conclusion

To The Petroleum Engineer:

I note THE PETROLEUM ENGINEER, Reference Annual 1950, gives a reprint of O. F. Campbell's article "Cylindrical Furnaces in the Petroleum Industry".

Under "Summary" on Page C-18 I read:

"In an all-radiant cylindrical furnace the coldest tube absorbs more heat than the hottest tube and the furnace adjusts itself with each tube absorbing its aliquot portion of heat in proportion to the fourth power of the absolute temperature difference between the flame and the tube."

Any one familiar with radiant heat calculations knows the Stefan-Boltzman law of radiation gives the transfer of heat as proportional to the difference of the fourth powers of the radiant and receiving absolute temperatures, not the fourth power of the difference.

Some confusion due to the above appears to give rise to the thought of the difference in absorption of heat by tubes of different temperatures. A comparison can be easily made for a specific case of 2000°A flame temperature and 1000 and 800°A tube temperature. The fourth power of the difference gives a ratio of heat transfer of 1 to 4.3. The difference of the fourth powers gives a ratio of heat transfer of 15 versus 15.6, or 4 per cent difference for the 200° drop in tube wall temperature. I do not believe this small difference is enough to make such a point of the difference of heat absorption between hot and cold tubes.

Donald J. Bergman

Engineering & Development Department
Universal Oil Products Company
Chicago, Illinois

Engine Maintenance

To The Petroleum Engineer
Publishing Co.

In your June, 1950 issue of *The Petroleum Engineer* there was a very interesting article by Mr. Philip H. Moore entitled "Maintenance of Internal Combustion Engines—Filtration of Air and Oil". This was a research project sponsored by the Volks Filter Company, England, and we find that it has much interesting information and is very applicable to maintenance problems of drill rig engines in the West Texas territory where sand is ever present in varying quantities.

We would appreciate being able to purchase six reprints of this article, if they are available, and we would appreciate it if you would consider this an order and would bill us for the cost of these.

—A. B. Reese, Jr.

Chief Oil Field Engineer
Superior Engine Division
The National Supply Company
Fort Worth, Texas

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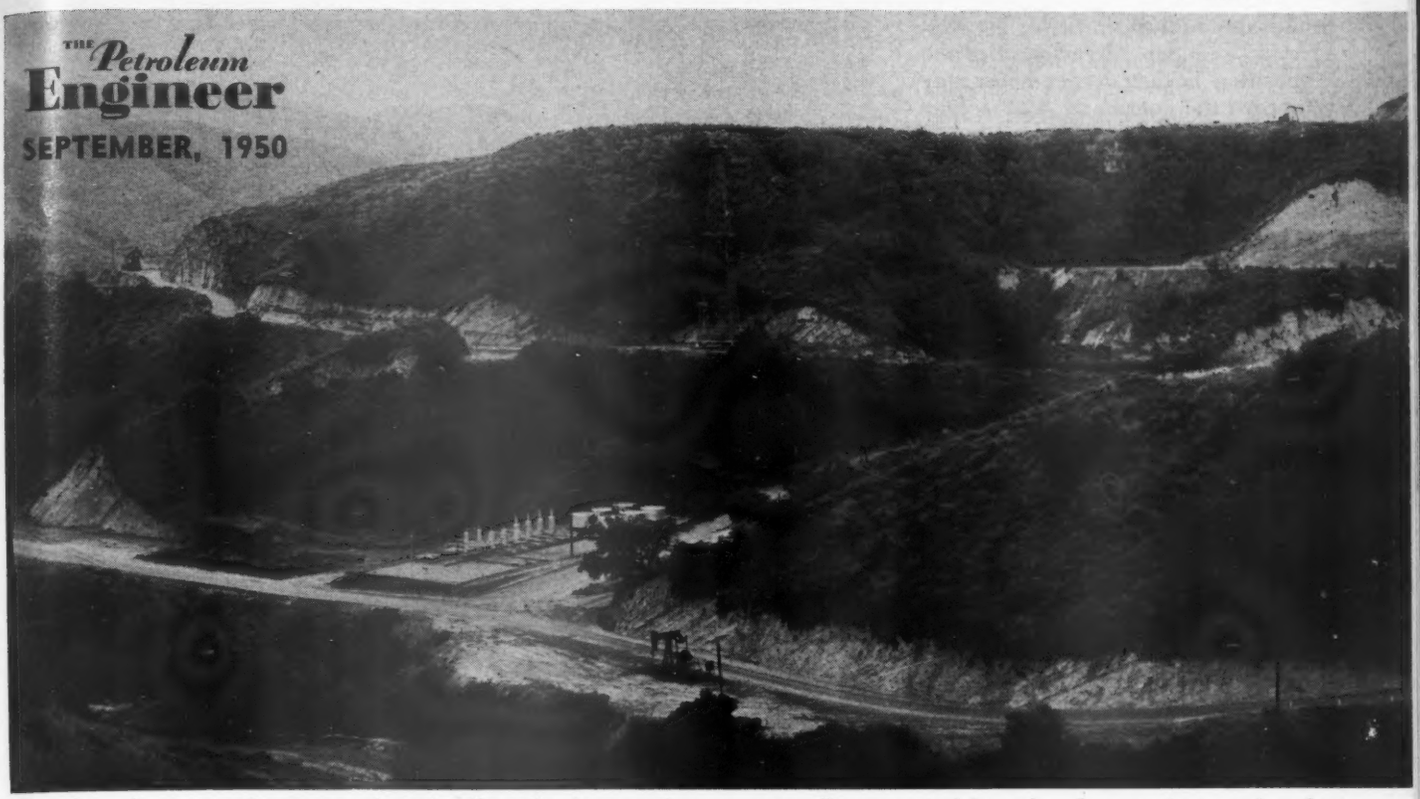
THE Petroleum Engineer
SEPTEMBER, 1950



Trap farm for separating gas and crude oil nestles in one of numerous valleys created by subsurface actions and surface erosion through the ages. Above the trap farm is a derrick and high on the mountain at right a pump is silhouetted.

Ventura Avenue — *Wonder Field*

In meeting the challenge of the strange field on the West Coast the industry learned new methods to conquer subsurface forces and developed a bonanza

RICHARD SNEDDON*

THERE is no question that Ventura Avenue is an amazing field in many respects. Despite extensive development, as a result of which some 700 wells are currently producing approximately 57,000 bbl of oil a day and are capable of producing considerably more, the limits of the field remain undetermined in several directions, one of which is down. Geologists estimate that the total reserves underlying the Ventura anticline amount to about 600,000,000 bbl, but they have been obliged to revise their estimates upwards many times since the Ventura field was discovered, and it is not unlikely that they may have to do so again. The producing formation that has already yielded 375,000,000 bbl of oil is of unprecedented thickness. So far as is known, indeed, it is the thickest sedimentary deposit in the world. One authority is sufficiently daring to suggest that oil may here be found to a depth of 40,000 ft if we ever develop techniques and equipment capable of reaching such depths. In any case, all the producing wells as of the moment are bottomed in the sand and no operator has yet come even close to finding the basement.

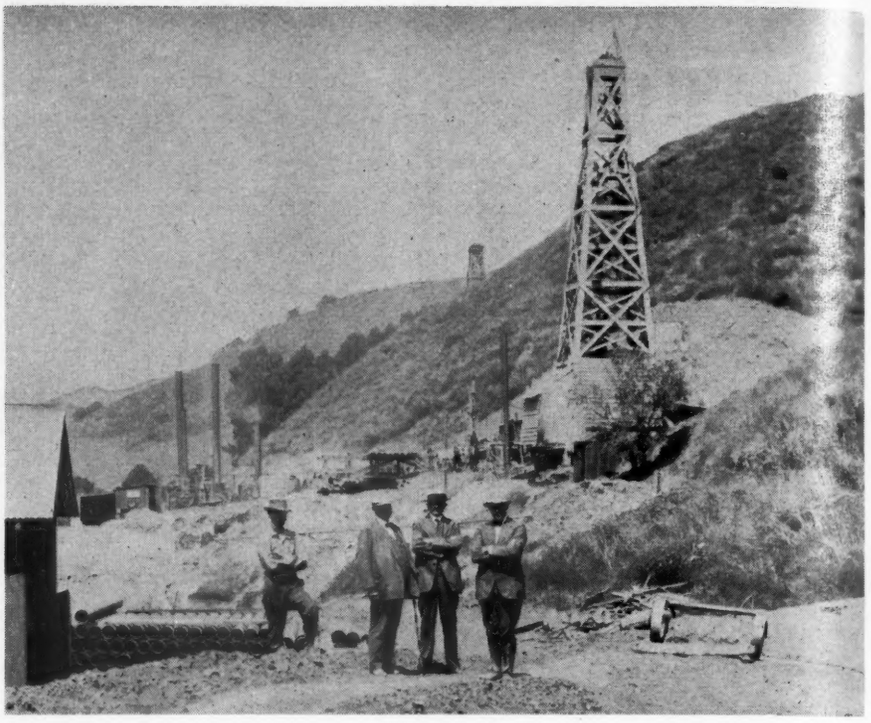
Laterally, the dimensions of the field are as indeterminate as it appears to be vertically. Practically all the production comes from an oval shaped area some five miles long by one mile wide at the widest point. At this writing Continental is drilling a first line offset to Shell's Taylor lease in the extreme west, and Lloyd Corporation is drilling an outstep well ¾ mile beyond the last proved production on the east. These, should they be successful, and it is not unlikely, will extend the field still further, and start new drilling campaigns at either end. Geologists pretty generally believe that the four adjacent fields, Ventura, San Miguelita, Padre Canyon, and Rincon, are in actuality one. The anticline seems to be broken between Padre Canyon and San Miguelita, but recent completions by Chanslor-Canfield Midway Oil and General Petroleum indicate that production is continuous across the Rincon and Padre Canyon fields. Two poor wells drilled by Continental

*Pacific Coast Editor

EXCLUSIVE

would also indicate a break between Ventura and San Miguelita. But the supposition is that deeper holes may yet prove the continuity of the four fields.

In its beginning at least, the story of Ventura Avenue pretty generally follows the usual pattern. The Avenue was long suspected by many local people to be the underground repository of considerable volumes of oil and gas. There were those who were familiar with gas seepages in the bed of the Ventura River and in various other adjacent spots, long before any actual commercial oil discovery in the area. L. M. Lloyd is said to have been riding over his cattle range one day in 1890 during the progress of a brush fire, when he suddenly found himself enveloped in a sheath of flame that seemed to issue from immediately underneath his horse. He escaped by virtue of some quick thinking and the proximity of a convenient embankment, over which he plunged with his horse to safety.



That adventure was not simple to explain at that time, but the elder Lloyd had a son, Ralph, now one of California's outstanding petroleum pioneers, who listened with more than ordinary interest to his father's recital of this peculiar experience. Some years later, in 1898 to be exact, after completing his geology studies at the University of California, Ralph B. Lloyd, returned to make a better qualified examination of the area, and ultimately to confirm his belief that here was an oil field. It is interesting to note that at this time, in collaboration with E. A. Rasor, he mapped the Lloyd property, which was a part of the Old Ex-Mission Rancho. This was undoubtedly the first attempt to define surface characteristics in the Avenue vicinity, and Mr. Lloyd is justifiably proud of the fact that it is still a pretty good picture of what it was intended to show.

The Ventura Anticline is about 17 miles long. It appears to have been crushed between two tremendous earth forces that have tortured the strata out of all semblance to their original deposition and relationship, and have thus produced a miscellany of structural oddities that renders precedent in many instances almost, if not quite, useless. What happens in the one well is no indication of what may happen in this. It is popularly conceded that, although in recent years, drilling in

Ventura oil field in 1926 reveals steel derricks among the wooden structures of earlier times.

At left the discovery well, State Consolidated Oil, Lloyd No. 1. It was completed December 20, 1914 for a small quantity of 50 gravity oil. The gentlemen posing in front are Ralph B. Lloyd, Joseph B. Dabney, E. J. Miley, and W. Blaylock. All became highly successful operators.

the Ventura Avenue field has been reasonably successful, every well is still completely exploratory, and each presents its own peculiar drilling and production problems. As a matter of fact, the area is looked upon as an ideal proving ground for the latent qualities and capacities of technical personnel, both in exploration and exploitation. This does not mean, of course, that operations are under the direction of untrained personnel. On the contrary, there are few fields where such a variety of unusual conditions is encountered and where continual experience in the area is so essential to ultimate success. Actually, operators in the field must be prepared for any eventuality. It has been frequently observed that techniques employed to solve a specific problem are quite inadequate when what appears to be the same problem again develops. Versatility and resourcefulness are, therefore, prime requisites of operational leadership in the area.

It is of especial interest that all producing formations in the Ventura Avenue field are in the Pliocene, and yet to the north and south are shallow fields producing from the geologically older Miocene. Ralph Lloyd speculates that there may even now be some intrusion here and there, by way of faults, from the Miocene, but is not at all dogmatic on the point. He even intimates that because, in most instances, wax-bearing crudes in California are derived from formations of Eocene age, and because Ventura Avenue has had its difficulties with wax, there may even be some leakage or migration from the Eocene.

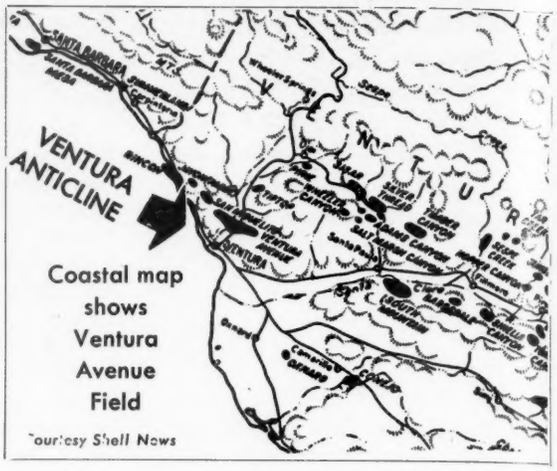
The anticline seems to be broken or offset at intervals, making four separate fields—Ventura, San Miguelito, Padre Canyon, and Rincon. Together these fields produced during 1940 from 1000 wells about 27,000,000 bbl of oil, of which over 21,000,000 bbl were produced in Ventura Avenue. The latter is now, indeed, the second highest producing field in California, being exceeded only by Wilmington. Some indication of the manner in which the subsurface has been crushed and warped may be gathered from the fact that the Avenue producing formations have so far been divided into 13 distinct blocks, defined laterally or vertically by various norms, such as stratigraphic location, accumulation characteristics, bottom hole pressure, or other distinctive conditions.

The history of Ventura Avenue development has been told so often, it is hardly necessary to repeat it in detail here. It may be pointed out, however, that in the early stages, that is, prior to 1922, when Shell Oil Company brought in its Gosnell No. 3 for 939 barrels a day, almost every well that was drilled was a loser—not that it didn't produce oil, but because techniques and equipment design had not sufficiently advanced to permit either economic drilling in the rugged terrain of which the Avenue is composed or adequate control of production under the tremendous gas pressures that were released by the drill.

As a measure of the difficulties and expense that were involved in these early efforts, Shell's Taylor No. 1 well, spudded in on August 11, 1916, was not completed until March 6, 1921, although it was drilled to 3552 ft. It produced about 238 bbl of fluid a day, of which almost 60 per cent was water—a pretty discouraging reward for such a valiant effort. About 2 years prior to this, the State Consolidated Oil Company had drilled its Lloyd No. 1 well, to 2250 ft for a small quantity of oil of 50° API. According to Lloyd, this well produced 1,500,000 bbl during its lifetime, but was finally wrecked by high gas pressure. Up to this time and for some time later cable tool drilling was the mode and a succession of Ventura Avenue operators had a very rough time with their respective ventures. In fact, it is safe to say that conditions in this field had quite a bit

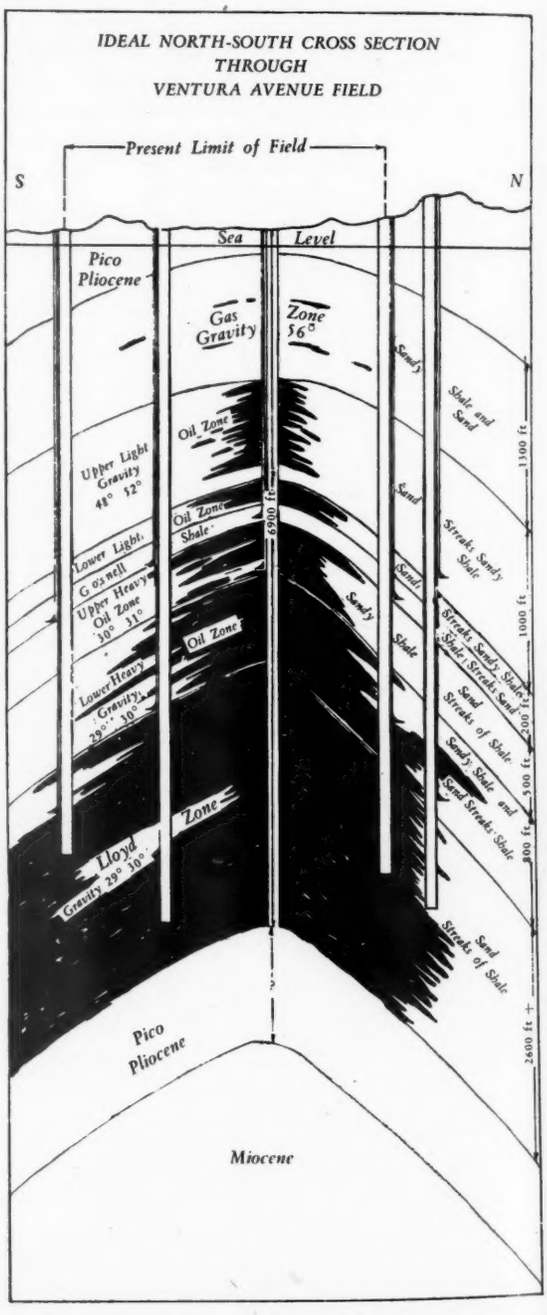
In the background rise the tiers of roads with wells and tanks planted on the mountain sides.

Ventura Field location map, Ventura County, California. Dotted line is surface anticline axis.



Coastal map shows Ventura Avenue Field

Courtesy Shell News



Oil zones in Ventura Avenue field after Hertel, 1928. Depths are shown in feet.

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to do with the subsequent development of high pressure fittings, adequate blowout preventers, and a new conception of the functions of mud.

Shell's Gosnell No. 3, completed in March, 1922, however, was the well that really sold Ventura. It came in under control for 939 bbl of oil a day from a depth of 3855 ft, a paying proposition.

Production came from what was called "the lower heavy zone" and its success prompted the successful redrilling of several prior wells that had failed in the first effort to produce. Meantime Tide Water Associated Oil Company had taken over the old State Consolidated Oil Company lease, and in 1925 completed its Lloyd No. 9A at a depth of 5150 ft for a daily yield of 4639 bbl of 30 gravity oil, and 15,000,000 cu ft of gas. Later in the same year, Lloyd No. 16 added to the optimism by repeating the success of No. 9A. As may be well imagined, these events precipitated a drilling boom of sizable proportions, and production figures fully substantiate the fact: In 1924, the total production from Ventura Avenue was 1,831,903 bbl; in 1925, it was 6,999,403 bbl, and in 1926, it had skyrocketed to 14,795,495.

From this time on, the drill steadily bit deeper and deeper into the pay sand, equipment and techniques began gradually to improve, and yields in general became correspondingly higher. At the present time well depths range from 3000 feet to 14,000, and completions are much more certain than they were in the haphazard early days.

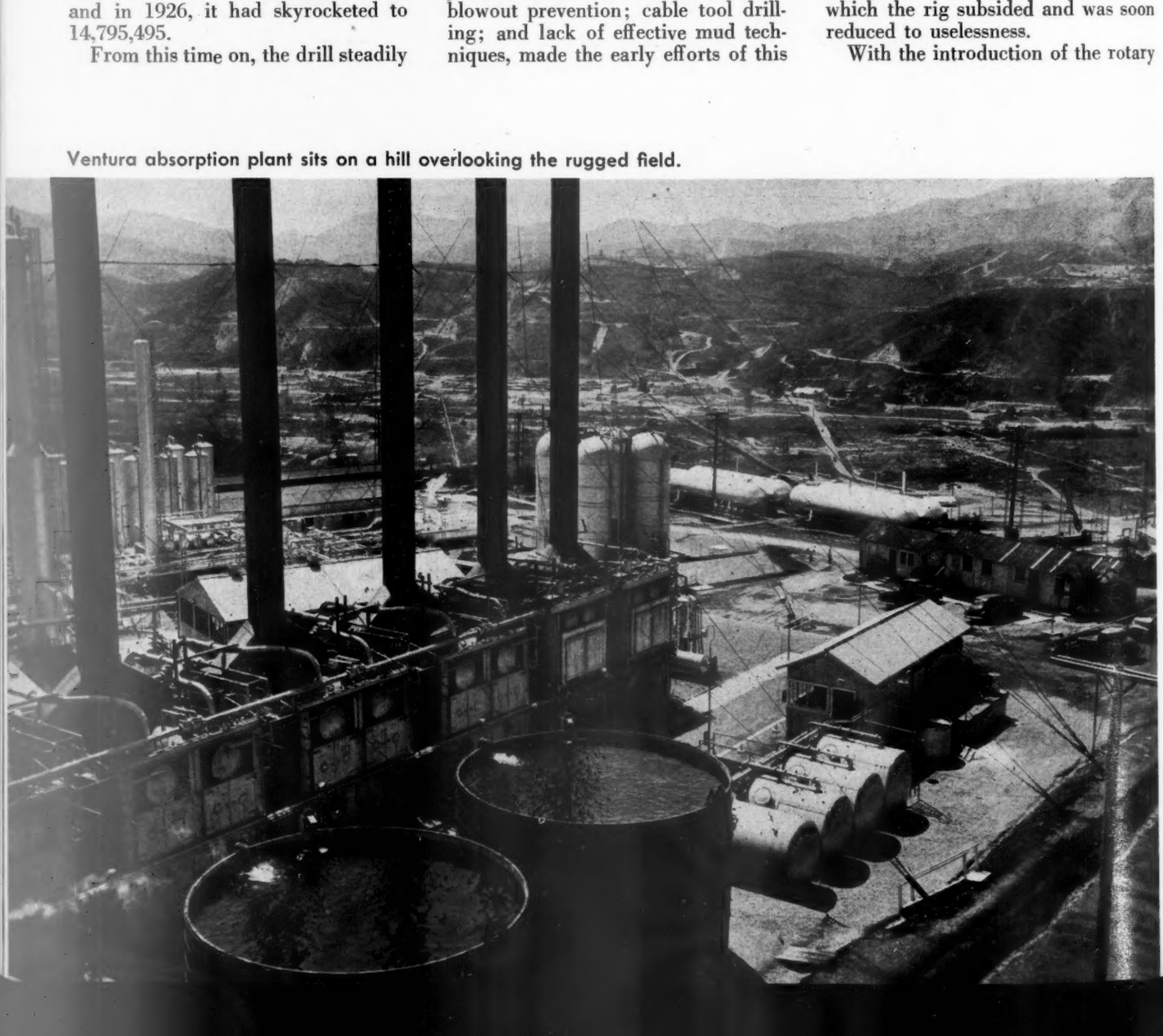
Shell and Tide Water have long been the major operators in the field. They are currently producing about 25,000 bbl a day each, which represents about 85 per cent of the total. Up to the present time the production of these two companies alone has been about 340,000,000 bbl, and the end is not yet. Shell's Taylor 73, which was completed in 1932, had produced over 2,000,000 bbl by November, 1946, and today is still capable of doing 200 bbl each 24 hr. Tide Water's Lloyd No. 83 came in on New Year's day, 1932 for 5000 bbl and has since produced almost 4,750,000 barrels. General Petroleum came into the field about 1918, and in a smaller way its successes and operational experiences parallel those of the two largest producers. Unprecedented bottom hole pressures, 5700 psi in Barnard No. 27; inadequate blowout prevention; cable tool drilling; and lack of effective mud techniques, made the early efforts of this company, too, a rather precarious adventure.

Other companies now active in the area are Lloyd Corporation, Ltd., British American Oil Producing Company and Bolsa Chica, and Pacific Western. Some conception of what has been done in the way of improving operational skills and processes may be derived from the fact that in 1921 it took 4½ years to drill one well to 3500 ft; in 1928 some six months were required to drill to 7500 ft; in 1948 wells were drilled to 10,000 ft in less than 90 days.

All this is a very definite indication of technological advance that makes a very interesting story. It should be noted first of all that until about 1922 all wells in the Ventura area were drilled with cable tools, and when a high formation gas pressure was encountered, controls were practically hopeless. This will be understood when it is noted that bottom hole pressures as high as 9000 psi have been recorded in the Avenue wells. The result of the gas pressure was in the early stages, that in many instances the wells blew in out of control, making great craters in the earth, into which the rig subsided and was soon reduced to uselessness.

With the introduction of the rotary

Ventura absorption plant sits on a hill overlooking the rugged field.



Ralph B. Lloyd, pioneer operator in Ventura field, which is on the old Lloyd Ranch. He is president of Lloyd Corporation, Ltd.

system, the wells were first drilled to the top of the producing formation by rotary, and then completed with cable tools. This helped some but not much. Pressure fittings were made of cast iron; little was known of the mud function; the relationship between weight of drilling string, rotary speed, rate of penetration, and direction, had not yet been established; and drilling techniques were far from that advanced state of flexibility and effectiveness they have since attained. In consequence high gas pressures continued to raise havoc with drilling operations and successful completions were not too common.

In due time, however, cast iron fittings gave way to steel; a new technician came into the picture—the mud engineer; and slowly the unruly forces of nature were licked by a determined group of operators who stuck obstinately to the job until they knew exactly what they were fighting. It took a lot of time and money to reach this state of understanding. One operator says that before the rampant gas had been tamed, some $4,000,000 had been spent in wells that blew in. Even today, the utmost care has to be exercised in some instances to be sure that formation pressure is not released in full force at any time, as it tends to collapse casing, even to cut solid hunks out of the liners, and in general to turn an orderly system into a pretty hazardous venture.

The first contribution toward a more effective control of the completion process was the development of the rotary drilling method, particularly the mud column, which was such an important part of the process. This static head in itself was enough in many cases to keep the well from coming in wild, but it was soon found that the ordinary weight muds that were effective in other areas were altogether too light for the high pressure pools in Ventura Avenue. Then began an intensive study of drilling muds and their function that has been carried on without surcease to the present time; and has made Ventura Avenue the greatest spot in the West for the schooling of mud engineers. The practice now in this area is to use muds weighing from 110 to 120 lb per cubic foot and the proper application of these has perhaps done more than anything else to assist the efficient and economical development of the field. It should, of course, be emphasized that coincidental with this advance, there came pronounced improvement in blowout preventers and high pressure fittings, which added greatly to both operational security and personal safety.

Also of great consequence in the definition of effective techniques was the growing understanding of subsurface conditions. The sporadic successes of early wells soon revealed that the Ventura anticline was far from being the perfect structure it had been assumed to be. Wells apparently drilled to the same formation and in immediately adjacent areas turned out quite differently. One might be a good producer and its partner drier than the Sahara desert. In time the reason for these deviations and discrepancies were disclosed by a combination of electric logging, paleontology, and well exercised processes of deduction.

These not only confirmed projections and conclusions, but gave further information that disclosed major thrust faulting and folding, and all sorts of malformations, without knowledge of which drilling could not have progressed to its present advanced stage in the area or, at best, successful completion would be more a matter of accident than design. Despite all this increased understanding of subsurface conditions and operational know-how, however, the shattering of the anticline is so irregular that the probability, even in the most favorable location, of running into some apparently quite unrelated interval is still always present. Logging and coring in critical sections thus are virtually routine. The rewards for this constant vigilance are to be found in the almost uninterrupted record of successes that experienced operators in the field are now enjoying.

Speaking again of mud techniques, which have played such an important part in the drilling of the Ventura wells, it may be said that the true significance of mud was not fully realized until about 1928. In the beginning mud was just soil and water, the soil sufficiently fine to stay in suspension and the whole sufficiently heavy to

A network of roads on the rough terrain gives evidence of the fact that drilling a well at Ventura usually requires a major road building project. Several wells are put down from each levelled out drilling site.

This view of Ventura Valley shows a new extension to the field and gives a glimpse of the gradual march of derricks into the orange and grapefruit orchards of the rich valley. A Ventura well may perch on a hill or nestle in the valley.

carry off cuttings. It is probable that Hal Marsh of General Petroleum Corporation should have credit for an early intelligent approach to the mud problem when early in the proceedings he developed a funnel that could be used right on the rig for the rough measurement of viscosity. Meantime a Tide Water Associated mud reclamation plant found it possible to desand and rethicken mud in a 60,000-bbl bowl, and mud research became the order of the day. In 1930 a filter test at 2000 psi pressure was defined. Then the Stormer viscosimeter was calibrated for thixotropic muds.

Considerable work was now being done on admixtures of weighting materials and gels. A method was established for the reclamation of barytic muds. High pressure filler presses were devised. Along about 1936 chemical treatment of muds was begun; the silicate-soda ash treatment first, and later, phosphatic. Subsequently, emulsions, starch, oil-base, lime-base muds came into popular use. As a result of all this, the drilling art has progressed in a very substantial way. They used to tell the story about the old-timer who watched for the first time a young mud engineer using a funnel viscosimeter and finally in exasperation yelled, "Hey, son, hurry up and get that bugle the hell out of here!" Nonetheless, if it hadn't been for that bugler and his kind, the drilling of Ventura Avenue oil wells would have been a much more hazardous venture than it is today.

On July 20, 1950, Lloyd Corporation, Ltd., landed 12,805 ft of 7⅝-in. casing in its Lloyd 35 in the D-7 pool, without mishap. The well was drilled to this depth in 76 days. All of which must come pretty close to establishing records for the heaviest casing string ever set; the longest casing string ever set; and the greatest footage of open hole. And all of which would hardly have been possible without the well-planned mud program that is now an essential part of every drilling project.

In certain sections of the field, considerable difficulty was experienced for a time with the presence of wax in the crude. It had a tendency to restrict the tubing in the wells and to choke up flow nipples. This difficulty was overcome by one of two methods, as follows:

1. The requisite amount of Kobe oil is added to increase the velocity of the well effluent and actually wash the wax out. This has to be very carefully contrived in many cases because of the high formation pressures and the danger of caving the liners, or cutting out perforations. The control is entirely a matter of the speed of flow.

2. The second method is to install a shale pot at the well head—the reduction of pressure causing a deposition of wax, which is cleaned out at regular intervals.

The most serious difficulties now encountered are lost circulation and corrosion of the water string. The mud engineers are by this time so thoroughly familiar with the causes of circulation loss and the remedial measures to be employed in the district, however, that the answer to the first is largely a matter of being constantly on the alert for the first warning signals. Thereafter the procedure is pretty well established. So far as water string corrosion is concerned, operators in the field are engaged in intense studies seeking to determine the underlying cause, and with the cause known it won't take long to stop further depradations of the electrolytes or bacteria,

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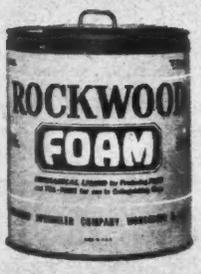
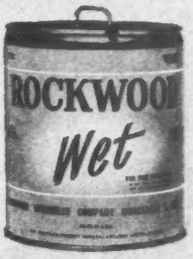
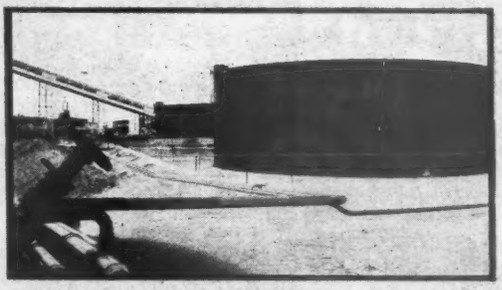


Rockwood FOAM. A mechanical liquid type FOAM for producting FOAM and FogFOAM for use in extinguishing fires.



Rockwood "Wet". Wetting agent or penetrant to be mixed with water for fighting fires.



Tank farm at a large electric power generation station protected with Rockwood fixed FOAM systems. The tank in the foreground is a 150,000 barrel steel tank (150' diameter by 48' high).

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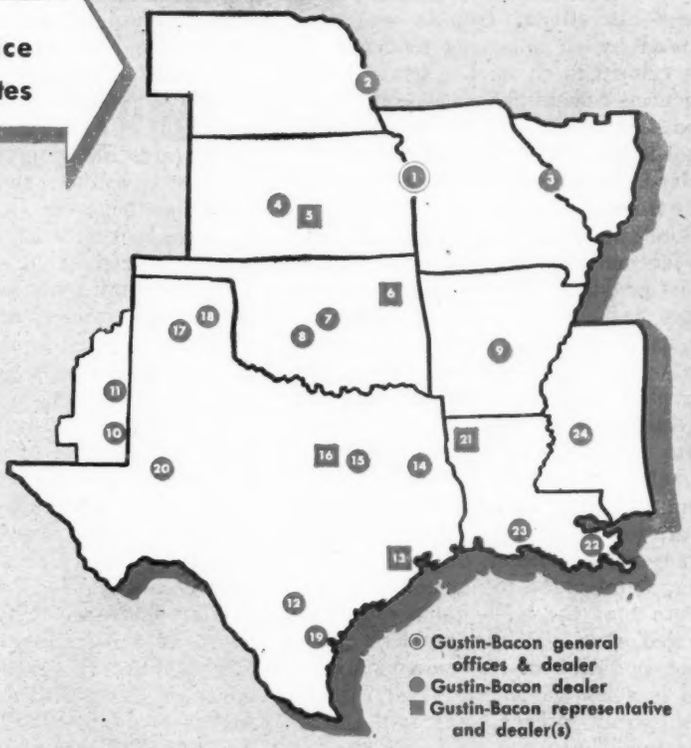

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   Safety, Inc.
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3. St. Louis, Mo: Safety, Inc.
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8. Chickasha, Okla: Chickasha Gin Supply Co.
9. Little Rock, Ark: Fire Appliance & Supply Co.
10. Hobbs, New Mexico: Union Supply Co.
11. Artesia, New Mexico: Union Supply Co.
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14. Longview, Tex: Baxter Sales Co.
15. Dallas, Tex: Fire Equipment Service Co.
16. Ft. Worth, Tex: Fire Extinguisher Service Co.
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17. Amarillo, Tex: Radcliff Supply Co.
18. Pampa, Tex: Radcliff Supply Co.
19. Corpus Christi, Tex: Southwest Equipment Co.
20. Odessa, Tex: Vaughn & Co.
21. Shreveport, La: McGriff Sales Co.
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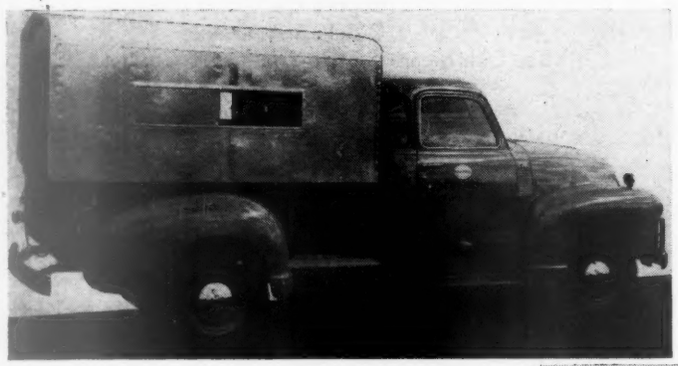
whichever are the guilty ones in this case. In cementing off the water string some operational trouble was also caused by an annoying tendency of the cement to channel in heavy mud. Accurate cement placement equipment and technique, as well as expanded knowledge of the physical factors involved, have now largely eliminated this trouble.

Once the wells are brought in safely under control, production offers no great problem. Most wells in the field come in flowing and then go through the usual cycle of gas lift and thence to the pump. Tide Water has a compressor plant to prepare the dry gas for injection; Shell uses high pressure traps for the same purpose. The removal of water from the crude is distinctly routine, ordinary electric dehydration apparently taking care of this essential without difficulty. However, it might be mentioned that the disposal of the well water must be carried out with the greatest care, since pollution of the Ventura River bed is a heinous offense that brings down wrath and sanctions on the perpetrator. The salt water is eventually purified and dumped into the ocean through a jointly owned disposal line operated by Shell Oil Company.

The Ventura Avenue field is not one of which one may speak in the past tense. Although it has already had an impressive history, and has been responsible in a large way for significant advances in method and equipment, its race is by no means run. Operators in the area are if anything more optimistic now about the future of the field than they were when it first began to boom back in 1922. It was then untamed, unpredictable, and for the next 10 years nothing was ever certain. But in due time operations became more effective, the tantrums of the subsurface gremlins were held under control, and good wells were the result.

We would certainly be remiss if we failed to give due credit for all this progress to the men who through the years have familiarized themselves with every eccentricity of a distinctly eccentric field. Great contributions have been made for drilling and production development by the persistent efforts and scientific savvy of such men as Ralph B. Lloyd of Lloyd Corporation, Ltd.; Ned Clark and Jim Arthur of the Shell Oil Company; F. W. "Pretz" Hertel and Martin Mears of Tide Water Associated; Alex McLean of General Petroleum Corporation; Fred Miller of Continental; George Ruggels of C.C.M.O.; the toolpushers and drilling crews; and all the specialists—both operating company and equipment manufacturers, each of whom has played a part in this great enterprise.

In conclusion, "wonder field" is an expression that sometimes, immediately following the first news of discovery, is tossed about rather loosely by promoters and quite well meaning but poorly informed community boosters. It is rarely, however, that experienced oil people permit themselves to be illogically excited into ecstasies of prediction or postulation. They are, indeed, much more inclined to err on the conservative side and it really takes a powerful lot of pretty solid facts to jerk a eulogistic exclamation out of an oil man. But, there isn't an oil man in California who doesn't heartily concur in the opinion that Ventura Avenue is in every sense of the word deserving of the appelation "wonder field". When, after 30 years of operation, the limits of an oil field are as indeterminate as the age of an elderly spinster, and it is still climbing productionwise, we have no recourse but to join in the enthusiasm and optimism of the local operators. Who should know better? * * *



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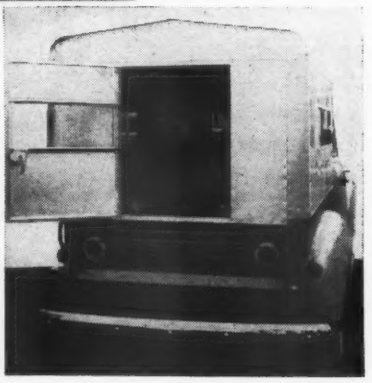

Rear view showing passenger door open in conventional manner. Seats in place along sides.

Entire rear door lifts up on hinges to permit loading of cargo items for "hot shot" delivery.

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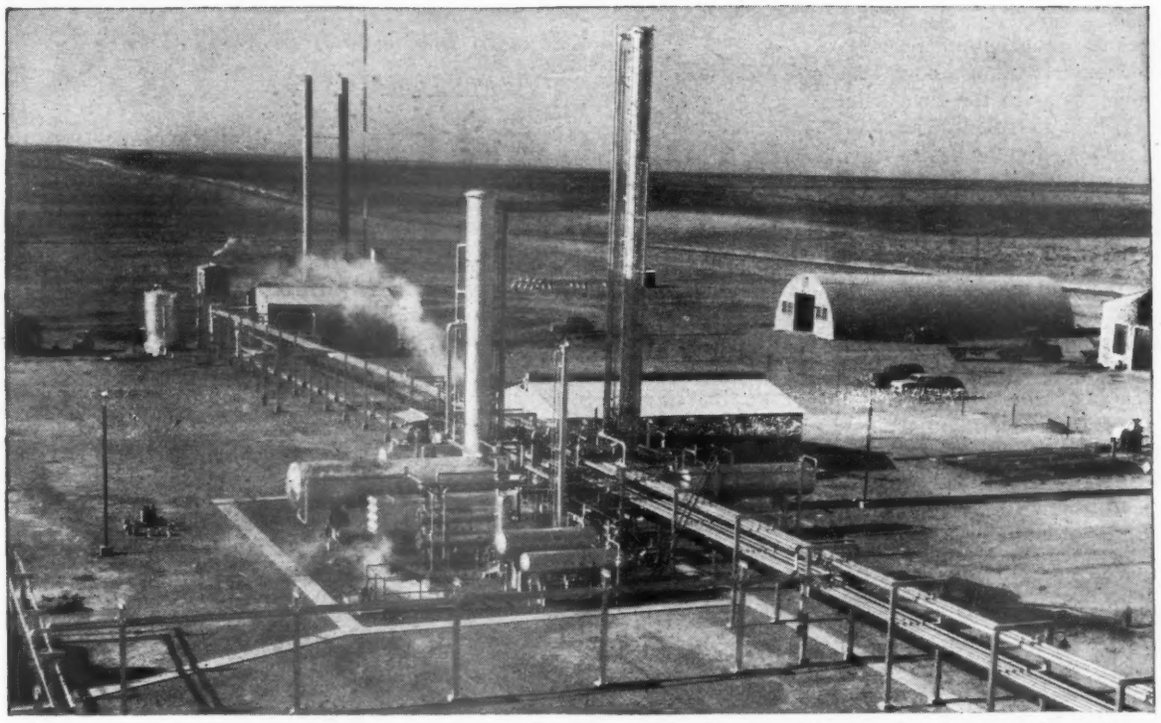
New Kansas Plant *brings gas to Denver*



Gasoline Plant, designed and constructed by Stearns-Roger at Lakin, Kansas, went into operation in December, 1949.

This new Gasoline Plant of the Colorado Interstate Gas Company has a capacity of 215 MMCF/day, and operates at 900 lbs. gauge pressure. It effectively removes condensable hydrocarbons that otherwise would seriously reduce pipeline capacity, and guarantees the required heating value of gas into the pipeline. The plant produces specification gasoline.

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PETROLEUM PROFILE

ROSS W. THOMAS

Vice President, Research and Development,
Phillips Petroleum Company

WHILE exact dates cannot be given here with certainty, along about 1926 the research group in the then small but lusty Phillips Petroleum Company had as its main—practically its whole—staff four men: George Oberfell, drawn from the engineering field to head the staff; Dick Alden, who did and still does pilot the organization now grown beyond recognition by its earlier self; Ted Legatski, steeped in the ways and habits and characteristics of light hydrocarbons, and Ross Thomas, calm of exterior, restless of mind, out of Illinois University and who made his first few years a scouting expedition to the oil and gas industries. Phillips' embryonic engineering department caught him early that year, only to lose him to the equally embryonic, similarly expanding research department.

Probably the most outstanding pioneering job Ross Thomas did in the next several years was that of formulating, organizing, and starting into business the "Bottled Gas" Department of Phillips, first known as the Philfuels Company, later converted to the Philgas Department. Its headquarters was transferred from Detroit, where its first important growth occurred, back to home office at Bartlesville, a small town in northeastern Oklahoma, which has in its city park the oldest or one of the oldest producing oil wells in Oklahoma. This LPG experience was crowded mainly into the years 1928-1931, when Ross was vice president and general manager of Philfuels. During that time and especially until 1940, he fought the battles of LPG specifications: of suitable equipment for the utilization of this product, consumption of which was expanding so rapidly that "growing pains" disturbed the industry; of test methods by which quality may be tested and controlled, and all the other problems and headaches incident to the launching of a new and important business venture.

By 1940 the parent company had travelled far in numerous fields, including chemical products manufacture, and Ross was drawn as managerial head of that department. Too soon indeed came World War II, and synthetic rubber, in which Phillips had become interested earlier and had affiliated with the Goodrich interests to produce. Combined with other companies in this crucial job to offset the crippling effect of loss of natural rubber supply, Thomas and his company share heavily in what without doubt is the greatest accomplishment of the American chemical industry—practical synthetic rubber.

At or about the war's end, he was appointed manager of the research and development department, 1945. In his new role, as vice president, he heads the Research and Development department, the patent department, and is executive vice president of Phillips Chemical Company, which operates the Cactus plant, making anhydrous ammonia and ammonium nitrate; the Port Adams plant making ammonium sulfate; the Philblack plant, producing carbon blacks for, especially, synthetic and natural rubbers; the Plains butadiene plant, butadiene being the indispensable ingredient of synthetic rubber, and the Borger, Texas, synthetic rubber plant. Verily, time shall not hang on his hands!

As is the case with any man in constructive big-time operations, Ross has many industrial organization memberships, including ASME, IPAA, and Compressed Gas Manufacturers Association. He is accused of being a top-rank amateur gardener and horticulturist "in his spare time". Use of this expression "spare time" within the hearing of his personal and business intimates brings amused grins and statements, which may be boiled down to "there ain't no sich animal".

Progress in the Gulf Tidelands

ONE of the most promising petroleum exploration programs during the last six years has been the offshore search for oil and gas fields in the submerged land under the Gulf of Mexico. More than 100 prospects, including salt domes and other structures, have been discovered in Louisiana and Texas waters by geophysical explorations carried on from small boats. Only 33 of the prospects have been drilled so far, and 23 of those tested have produced some oil or gas, according to a tabulation contained in the article beginning on page B-7 of this issue of The Petroleum Engineer.

Although the oil production from these offshore fields is only about 10,000 bbl daily at present, the discovery of so many new prospects by geophysics and the high percentage of oil and gas discoveries (about 70 per cent) indicate the potential importance of this new producing area. It is true, of course, that vast sums of money, more than $200,000,000, have been spent so far on the offshore program and that the present daily production by itself would be inadequate reward for such an expenditure. Even the large companies may be hard pressed due to the low rate of return on their investment. The present daily production, however, is not at all indicative of the potential producing capacity nor of the reserves that have been proved.

The offshore oil fields are not developed fully, the gas fields are closed in for lack of connections to market, and the oil wells are producing at restricted rates in accordance with good conservation practices. The present daily production, therefore, should not be used as a yardstick for measuring the economic success or failure of the offshore program. Operators have learned long ago that daily production at restricted rates has little meaning with respect to proved reserves. Wells capable of producing a million barrels during their life may have an "allowable" of 500 bbl or less per day.

The petroleum industry has made remarkable progress in adapting its equipment and operations to offshore conditions during the last five years; however, a great deal more work needs to be done to test and develop the offshore prospects that have already been discovered. It seems safe to predict that oil and gas production from offshore fields will be increased rapidly during the next five years as the present fields are drilled up and new ones are discovered,—provided that the industry maintains its freedom of enterprise and is not hampered unduly by the current dispute over the ownership of the leases.

K Marshall Fagin

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Louisiana and Texas Offshore Operations

HENRY C. CORTES and R. N. GSELL*

TWO geophysical methods have been used commercially in the exploration activities in the Gulf of Mexico. Gravity meters, or gravimeters were used by some, followed later by reflection seismograph.

Refraction seismograph was used by some for fast coverage with about 7-mile distances between shot point and recording stations. The follow-up again was reflection seismograph. The majority of companies, however, used only reflection seismograph.

Reflection costs have been about $25,000 to $50,000 per month, or from 2 to 3 times the cost on land. The work proceeds so much faster on water, however, that despite weather delays, the water cost per linear mile is less than on land.

At one time there were more than 30 reflection crews in the Gulf waters of Louisiana and Texas. At this time, however, there is only one reflection crew reported in Gulf waters. This difference is due mainly to three reasons: The title situation, the opening of new land discovery areas, and the easing of the nation's shortage of daily productive capacity.

It is estimated that 75 domes and structures have been discovered by geophysics in Louisiana waters and about 25 in Texas waters.

Types of Structures

The types of structures found in the Gulf are very similar to those inland. Geophysics shows this, and drilling confirms. Thus, there are shallow salt domes where the refraction seismograph predicted, and the bit drilled into salt at 300 ft below the water. Salt has been found at various lower depths, and there is one well (the deepest in the Louisiana Gulf) with a total depth of 14,451 ft in which there was no salt. The faulting patterns associated with shallow and deep on-shore domes appear to follow in the Gulf domes and structures. The depths at which oil or gas may be found offshore probably will far exceed the 20,521 ft depth of Superior's well, deepest in the world, in the State of Wyoming.

*Assistant Manager and Coordinator of Geophysics, respectively, Exploration Division, Magnolia Petroleum Co., Dallas, Texas.

Lease Forms in Texas-Louisiana

Those of you who have compared the offshore lease forms of Texas and Louisiana noted that in general the Texas form is more reasonable to the operator. Both are for a five-year primary term with 1/8th royalty on all hydrocarbons. Louisiana has two forms, one dated 1942 and in effect on leases taken in 1945 until the latter part of 1948, when the October, 1948, revised form came into use.

The first Louisiana form was so ambiguous as to a $200.00 per shut-in gas well clause that the State Mineral Board has, upon request, amended the 1942 form leases to conform to the 1948 form. This provides that where gas wells are shut in because of no gas market, the Lessee may, 90 days after completion and shutting in, pay the State $1.00 per acre for each 6 months period for a total period of 3 years, beyond the 90-day free period.

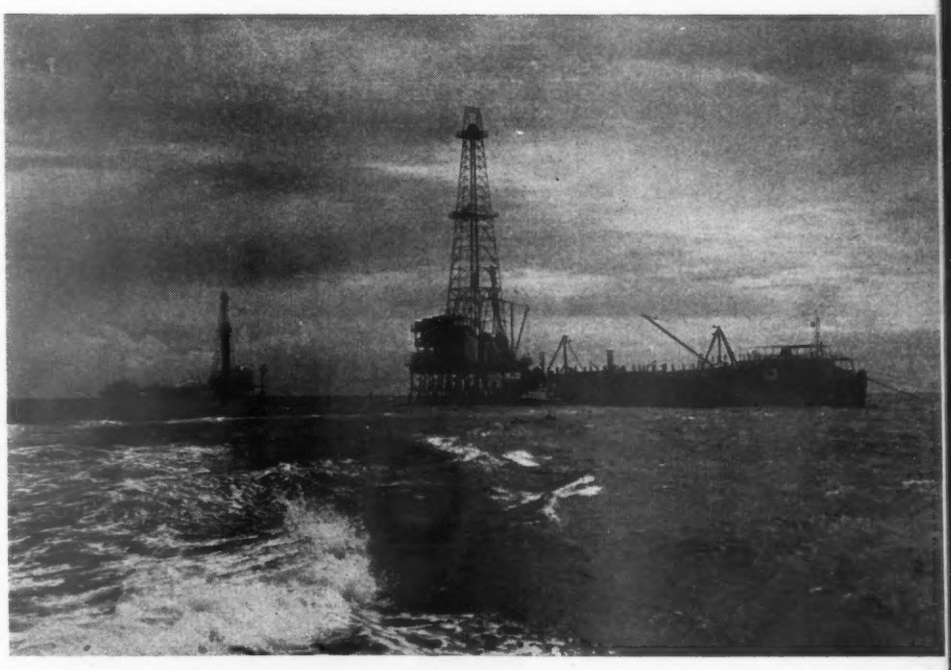
A second Louisiana amendment has been substituted whereby 660 ft offsets are not required except adjoining a private owner. The Texas form is similar, but is 1000 instead of 660 ft.

A third Louisiana amendment authorizes directional drilling from a platform location on one 5000-acre tract to another tract.

In addition, at its meeting on April 27, this year, the Louisiana Mineral Board authorized deletion of Clause IV of the 1942 form. It was an onerous provision regarding "declaring," at or about the expiration date, what part of a lease has been developed, "making known" to Lessor "the existence of domes and structures," release of acreage not under "actual development," and a forfeiture clause, if Lessee fails to obey the above provisions. Clause IV is not in the 1948 Louisiana form.

Both Texas and Louisiana forms provide for transfer, but neither has surrender-in-part provisions. By way of constructive criticism, it should be brought out strongly that the leases should be for 10 years, not 5, because operations are necessarily slower, more costly, and more hazardous than on shore. The various State Boards in control of leasing and developing, as well as federal agencies are, and have

Derrick platform-drilling barge type rigs used by Magnolia on two of its Eugene Island wells, Block No. 110, left, and Block No. 95, right.



EXCLUSIVE

been, very cooperative with the operators.

In August, 1945, the State of Louisiana held its first lease sale of the current Gulf play. Texas has held only one, that of November, 1947. Louisiana has received a total to date of about $26,500,000 bonus for 2,631,000 acres. Texas, on the one and only sale, received $7,000,000 bonus for 367,000 acres. Thus, the two-states' bonus totals are $33,500,000 for 3,000,000 acres. Not all these leases are in force at the present time. Some of the Louisiana leases were purchased after geophysical work, some before geophysics.

The average bonus cost per acre in Louisiana to date is $10.07 per acre, while that in Texas is $19.30 per acre. This difference is understandable, however, for three reasons: 1. Louisiana rentals are one-half the bonus price, whereas all Texas rentals are $1.00 per acre regardless of the bonus per acre. 2. Louisiana tracts cover 5000 acres, while in Texas the tracts within 3 miles seaward cover 640 acres, and farther out 5760 acres. 3. In the Texas sale, bidding was only for geophysical prospects.

Legal Angles

On June 23, 1947, the Supreme Court of the United States ruled that the Federal Government, not the State of California, had "paramount rights." The decision did not state directly that the United States "owned" the California "tidelands," even though the United States Attorney General specifically asked for such a decision.

There is no Federal law or other provision for the Federal Government or any of its departments or bureaus to lease, handle rentals, or regulate production in the waters offshore. A temporary arrangement was worked out between California and the Federal Government so that the oil business in the Pacific Ocean could be carried on, and equities maintained.

Meanwhile both Houses of Congress passed a bill confirming ownership in the States. President Truman vetoed the bill. One branch of Congress overrode the President, while the other failed to override by the necessary two-thirds vote basis. A number of compromise bills are now in Congress.

The United States Attorney General then sued Texas and Louisiana, claiming the same rights as in the California case. Texas claims a different status, however, because it was a Republic prior to joining the Union, and asked permission to take testimony and introduce evidence. Louisiana brought up evidence not used in the California case regarding pre-United States Constitution colonial treaties. On June 5th the U. S. Supreme Court handed down decisions in favor of the Federal Government. The Louisiana decision was 7 to 0 with Justices Clark and Jackson not voting. The Texas decision was 4 to 3, with Justices Frankfurter, Reed, and Minton dissenting.

Development Costs and Hazards

The cost of exploration wells up to the present time is from two to four times higher than similar wells in marshes, and from three to five times higher than dry-land-area wells.

Gulf of Mexico field development wells, as contrasted with wildcat or exploration wells, cost more than on land, but not in the above proportions; especially considering that several wells can be and have been drilled from the same platform.

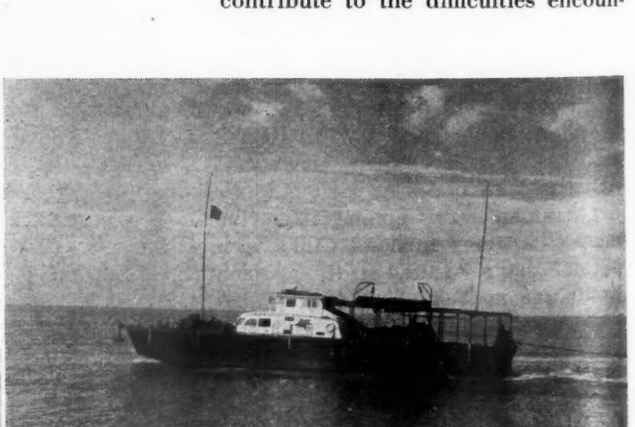
All leases have a common fee owner, and the tracts are from a minimum of 640 acres to 5000 acres. No 5-, 10-, 20- or 100-acre ownerships are found, and no vacancies, roads, or rights-of-way interfere with operations and well spacing plans.

Thus, although the well costs are two to five times those on shore, much less than 1/5th the number of wells may need to be drilled in the Gulf as compared with land fields.

The daily production allowables in the Louisiana Gulf are about twice those ashore, which makes a considerable difference in payout time.

The hazards of offshore operations are, and always will be, greater than in the bay areas, still greater than marsh areas, and, of course, greatest as compared with dry land areas.

Corrosion, fogs, and hurricanes contribute to the difficulties encoun-



Geophones attached to a cable are carried on the drum mounted on the seismograph recording boat shown here. The geophone-cable is released as the boat moves forward. The engine is used to winch in the cable after the shots have been recorded.

A shot is being released here by members of a seismograph shooting crew. The shot point is marked by a balloon, and the shooting boat moves a safe distance away from the shot before it is exploded (right).

tered. Current and wave action are always potential threats in the Gulf, seldom in the bays and marshes, never on land. Corrosion is severe in the bays and marshes, worse in the Gulf.

Derrick platforms have withstood hurricanes and severe storms, however, and drilling barges are designed to ride them out.

Derrick Platforms

In the early 1920's, Colonel E. F. Simms had three or four oil and gas leases, bonus free, from the State of Louisiana, covering nearly all the Louisiana Gulf waters. Instead of a bonus, he had to drill at least one well on each lease. Today's derrick is a far cry from the small 98-ft wooden derrick he erected in the gulf waters of Cameron Parish on the west bank of the Calcasieu River, where the Gulf of Mexico was only a few feet deep. The early rig reached a total depth of 2600 ft, however, before abandonment.

Superior and Pure's 1937 island platform, a mile off Cameron Parish in 14 ft of water, was the forerunner of those used in present drilling operations. For certain water depth, current and wave conditions, it is probable this type will continue to be used. Its material and erection costs have been cut about in half in the steady evolution that has been, is, and will continue to take place in the Gulf.

The next change in drilling operations, which was adopted by several companies, was the construction of a smaller and less costly derrick platform for use with a barge where most of the power, mud pits, water, pipe, and supplies are carried. The barge is anchored next to the derrick platform. Most of these are U. S. Navy ships, such as LST's and YF's.

One company then followed the Texas Company marsh, bay, and lake submersible drill barge idea. This is a ship type unit with drill and derrick mounted thereon, and is sunk to water bottom in places where the ship deck is still sufficiently high above the Gulf water level. This total water depth at present is understood to be no greater than 25 ft. The Texas Company inshore barge is used generally in waters not greater than 12 ft to 15 ft deep.

Many new types of equipment for drilling in the ocean are in the drawing board or actual trial stage. There is a new combination drill platform and barge which should cut costs and time very much. Important improvements are expected to be made in the latest drilling platform.

This new drilling platform foundation was conceived and developed by Col. L. B. DeLong*, together with the Pointer Williamette Company of Portland, Oregon. This new type foundation is to be supported by six steel caissons, 6 ft in diameter, the thickness of the steel in the caissons varying according to the water depth, or unsupported height above the fixed ground level. In cases where water is 40 ft deep, it will be necessary to have the steel in the caisson about 1 in. thick. The superstructure for the drilling equipment will consist of a barge 8 ft deep, 87 ft long, and 44 ft wide.

Method of Installation

The superstructure of the drilling platform, which is really a barge, will be floated to the well location and the 6-ft caissons will be dropped through wells in the barge the same as spuds are dropped on work barges.

A rather unique device was developed by Col. DeLong, which is called the Air Bag Caisson Driver. The air bag caisson driver can be operated by fluid pressure, steam pressure or air pressure, and consists of two sets of gripper rings made from hard rubber, which, when expanded by air or hydraulic methods, will grip the caisson and prevent the barge from moving in a vertical direction on the caissons. The air bag jacks are located between the two gripper sections. By inflating the air bag jacks, the platform or barge may be raised or lowered up or down the caissons. Application for patent for this method of installation has been filed with the U. S. Patent office by the inventors.

When the barge is floated into the well location and the caissons dropped the air jacks are put into action and begin jacking against the caissons. The caissons are forced down into the mud bottom by the weight of the barge, which is about 200 tons. As soon as the resistance of the mud bottom is greater than the weight of the barge, the barge begins to climb up the caissons and clears the water. Jacking is continued until such time as the bottom of the barge is above storm wave heights, usually 30 to 35 ft above normal water level. The air jacks require about 1½ min to go through one cycle of operation. Each cycle either jacks the caisson down 6 in. or raises the barge 6 in. upward. It would thus require 30 min to jack 10 ft on the caissons.

These jacks are capable of developing a bearing of 300 tons on each of the six caissons. As this may be insufficient bearing to hold up drilling loads, it might be necessary to drive the caissons with a pile driving hammer until about 500 tons bearing capacity is developed per caisson.

The first platform of this type was built by Col. DeLong as a trial structure at the Alexander Ship Yard in New Orleans, and was first tried out

*Owner of the Marine Contracting Corporation.

in the Industrial Canal there in March of this year. His trial was a success and Magnolia-Continental-Newmont entered into a contract with the Marine Contracting Corporation for installing a structure of this type for our Well No. A-1, South Pelto Block 20, which is located off the coast of Terrebonne Parish, Louisiana, approximately 12 miles from land, south of Wine Island Pass. This location is in 40 feet of water.

Our engineers believe this type of foundation will prove to be effective and should considerably reduce foundation and other costs.

Oil Discoveries

As of May 29, 1950, there have been 12 oil fields discovered in Louisiana coastal waters. Range in depth is from 1700 to 11,658 ft. The first well since Creole was that of Kerr-McGee-Phillips-Stanolind completed in 1947. Three discoveries occurred in 1948, four in 1949. Thus far in 1950, two oil fields have been opened up.

The daily production at the middle of May was about 10,000 bbl per day. A summary of offshore drilling to date is as follows:

Total Wells Drilled	125
Wells Drilling	20
Prospects Drilled	33
No. Fields Discovered	23
No. Oil Wells	48
No. Gas Wells	19
No. Dry Holes	58

Note that 23 our of 33 prospects are oil or gas discoveries, and does not include such geophysical confirmations as where salt was penetrated but no gas or oil well resulted. Thus the Louisiana Gulf average is 2 fields out of 3 wildcats as against the land average of 1 out of 4 or 5.

Note also that the dry hole total includes deviations from platforms where one producer or dry well was drilled previously.

Gas Discoveries

The first gas field discovery in Louisiana Coastal waters was brought in during March, 1948. Three more that year made a total of four for 1948.

Six Louisiana Gulf gas fields were discovered in 1949, and two more in 1950 thus far.

In Texas, there has been one gas discovery. This is one of seven tests in Texas waters, the others being dry holes.

Thus, there is a total of 13 gas discoveries in the offshore areas of the two states to the present.

One gas deal has been announced, that of Texas Eastern with Stanolind-Ohio-Melben for the gas discovery well and area about 6 miles off Galveston Island, Texas.

Several deals are in various stages of consideration for marketing gas discovered in Louisiana Gulf waters.

Pipe Lines

Oil can be barged out after one discovery well is completed. When sufficient production is established, a pipe line can be laid to shore. Prior to shore entry, the line needs to be buried 3 ft below the Gulf floor from the 8-ft water depth to shore. This is accomplished by jetting.

The first oil line constructed in the current period of development was three miles of 4 in. laid in water up to 30 ft in depth in the Bay Marchand oil field, in La Fourche Parish, Gulf of Mexico waters. The Creole oil field has a 1-mile oil line that has been in use over 10 years.

From the Saudi Arabia mainland, 17 miles of 12-in. oil line was laid to Bahrein Island. Despite swift tides and submerged coral reefs, the 12 in. was laid in 91 days, 65 of which were working days. Better progress may be expected in the Gulf.

Gas lines will be laid in a similar manner to oil lines, except that they may need weighting for sizes larger than 10 in. diameter. United Gas, in 1941, laid a 14 in. line 24 miles through Lake Ponchartrain, a landlocked shallow salt water bay near New Orleans, rather than go 37 miles around in the marsh. No trouble has been experienced.

Thirty, fifty, or a hundred miles off the coast of Louisiana is much nearer most markets than the Rio Grande Valley, both distance-wise and money-wise.

Oil Reserves

There is only one way reserves may be estimated at present, as insufficient wells have been drilled. That way is to take the reserves from the shore inward for a given number of miles, and use those reserves for a similar sized water area. In doing this, we come up against the problem of depth of water from which oil may be produced commercially. There is the further question of geologic section differences of parts of the Texas Coast, and how much of the Texas offshore area will have salt domes.

From the on-shore evidence, we believe we are justified in assuming that there will be a number of fields of from 25 million to more than 100 million bbl, and smaller ones all the way down to those that justify exploitation on shore, but that, due to greater cost in the Gulf, might not be commercial in the Gulf waters.

Probably the best thing that can be done at this time is to accept the various estimates of from 2 to 10 billion barrels. Estimating U. S. reserves between 25 and 30 billion barrels, either of the above figures represents a substantial addition to known reserves.

Gas Reserves

Using the same reasoning for estimating gas reserves, we may assume that there will be a number of gas fields whose reserves will run from 50 billion to more than a trillion cu ft, and many smaller ones where the greater cost in the water will not justify development. The total Louisiana and Texas offshore gas reserves may be estimated at this time as being somewhere between 4 and 12 trillion cu ft, with U. S. reserves between 175 and 200 trillion. Either figure here represents a substantial addition.

Summary

In general all costs will run higher in the Gulf than on shore, in bays, or in marshes.

Commercial oil production exists at present, and gas sales will begin this year in one or more areas.

The Louisiana and Texas Gulf waters contain one of the best virgin oil and gas reserve areas in the United States.

Due to slower and more costly operations, the Gulf play may be slow in moving up to an appreciable daily production.

While the State and Federal departments concerned have been very cooperative, some of the lease terms in both state leases are not suited for ocean operations. Time should demonstate where changes ought to be made.

The main high cost exception will be that, in many cases, a much lesser number of gas or oil development wells need be drilled because no small fee ownerships are present; also one or more deviations may be made from the same platform.

Since 1946, when the first drilling began in the present play, improvements are helping in cutting costs, speeding up operations, and increasing safety.

Derrick platform costs have been cut. More automatic electronic or other devices will come into use.

The geophysical equipment and techniques underwent marked evolutionary changes and lowered costs.

Out of some new designs to be tried out, there are possibilities that may make much greater differences in platform design.

In conclusion, much oil and gas will be produced from the Gulf waters of Texas and Louisiana. The profit or loss will depend on some known and some unknown factors. * * *

A Simplified Method for Design of Rod Pumping Installations

The Mechanical Engineering Group of The Atlantic Refining Company presents the methods of selection and calculations to be followed in design of a sucker rod pumping installation. Tables and graphs are included to provide short-cuts to equipment selection.

THE most economical artificial lift installation is one representing the minimum investment that will produce a well to depletion with the lowest unit operating cost.

Every well is a separate and distinct problem and, in order to select the correct equipment, it may be necessary to make certain assumptions in regard to present and ultimate oil, water, and gas production, pumping depths, fluid levels, and desired production rates. In older fields, data relative to new wells may be acquired from a history of the older producing wells, and a much closer approximation of the present and future requirements may be made. In newer fields, many factors are unknown and all the data about reservoir performance and characteristics must be noted and applied in making the assumptions upon which the selection of pumping equipment is based.

A sucker rod pumping installation design is begun by estimating the future production rate and the depth from which the well must be pumped. Calculations may be made in several ways, but certain assumptions must be made in regard to the size of some parts of the installation. When these assumptions have been made, the size of the rest of the equipment may be calculated.

There exists within the limits of the size of the pump plunger, length of stroke, and speed of operation, an almost unlimited number of possible combinations of these factors. Some of these combinations will produce the desired fluid with less load and less torque than other combinations and will, therefore, cause less wear and tear on the equipment.

A discussion of each part of a pumping installation follows . . . giving the pertinent factors that influence the design of the equipment. These parts include: The subsurface pump, the sucker rod string, the pumping unit, and the prime mover. The calculations that must be made indicate, within limits, the best plunger size, length of stroke, and speed of operation at which optimum conditions should be obtained.

Various tables and graphs are included to facilitate the selection of equipment and to eliminate many of the calculations necessary in this work. The derivation of formulas and the actual calculations involved in all phases of selection are too lengthy to include and are beyond the scope of this report. The graphical presentations and tables are based upon the latest available data and upon calculations made to determine the best possible combination of factors necessary for selection. If a knowledge of the basic calculations and formulas is desired, the references given in the appendix of this paper should provide a source of information.

Sucker Rod Pumps

The first step in selection of a rod pump is to determine the amount of fluid expected and desired and to select a proper size plunger to give this production with the minimum peak polish rod load under a given set of pumping conditions. By computing the actual net plunger stroke under varying conditions, with various size plungers, and obtaining the corresponding loads and displacements a comparison should indicate the size plunger that will give the maximum production with the minimum load.

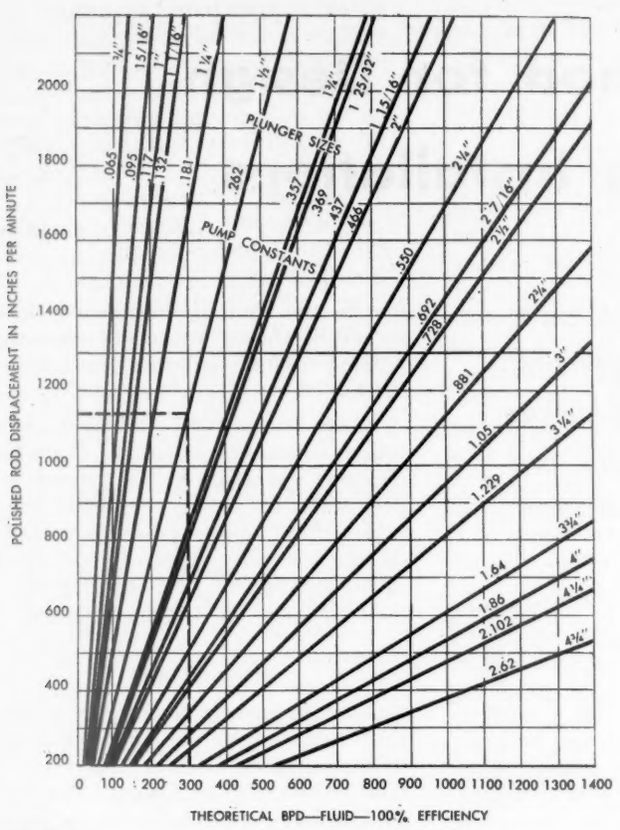
The smallest size pump that will handle the desired volume of fluid should be chosen, especially when the volume of fluid entering the hole is limited.

In the case of high fluid levels, agitating pumpers, or small diameter plungers operating at high speeds in deep wells, the actual production may exceed the computed production based on the net plunger stroke. In such cases volumetric efficiencies greater than 100 per cent will be obtained.

Rod Strings

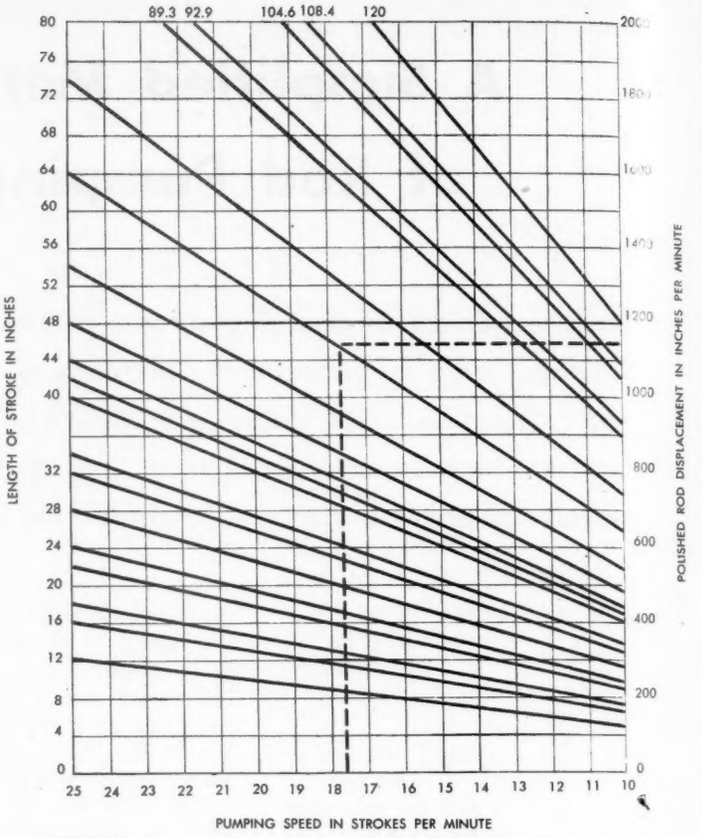
The type and size or sizes of sucker rods required should be determined by the pumping loads and the type of fluid to be lifted. In Tables 1 through 10, limiting depths are given for various rod combinations, with various plunger sizes, pumping at 20-64 in. strokes per min, and with the fluid level at the pump. If the pumping conditions differ from the conditions noted above, the limiting depths of the rod combinations will differ from those in the tables. The tables should be used only as a guide, therefore, and the accelerated upstroke load should be checked against the endurance limits of the rods to determine whether the rod string is adequate or whether a smaller rod string could be used. Approximate endurance limits of various types of rods are given in the Appendix. The percentages of each size rod to be used for the various rod combinations and plunger sizes are given in Table 11. In these calculations, the theory of proportioning the stresses in the top rod of each section of the rod string was used. When the rods are proportioned in this manner, each size rod carries its share of the load, and no one section is overloaded. From Figs. 6, 7 and 8, the weight of the rods and fluid can be determined. Rod and tubing stretch results in a pump plunger stroke shorter than the polish rod stroke; however, overtravel due to accelerated loading increases the stroke of the plunger. These factors must be taken into consideration in calculating the net plunger stroke. Rod, tubing, and corrected total stretch can be determined from Figs. 9, 10, 11 and 12. Estimated overtravel can be determined from Fig. 13.

EXCLUSIVE



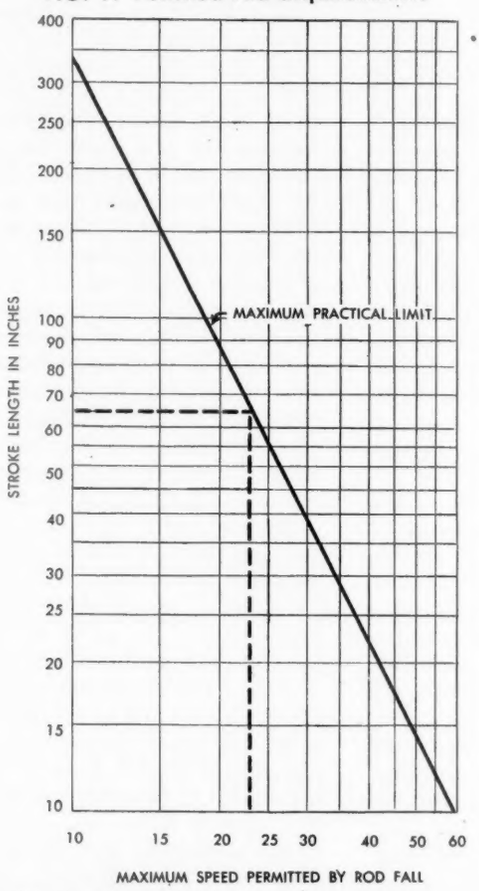
EXAMPLE—
Given: Theoretical production = 300 BPD. Pump plunger = 1½ in.
Determine: Polished rod displacement. Result: 1136 in./min.

FIG. 1. Polished rod displacement.



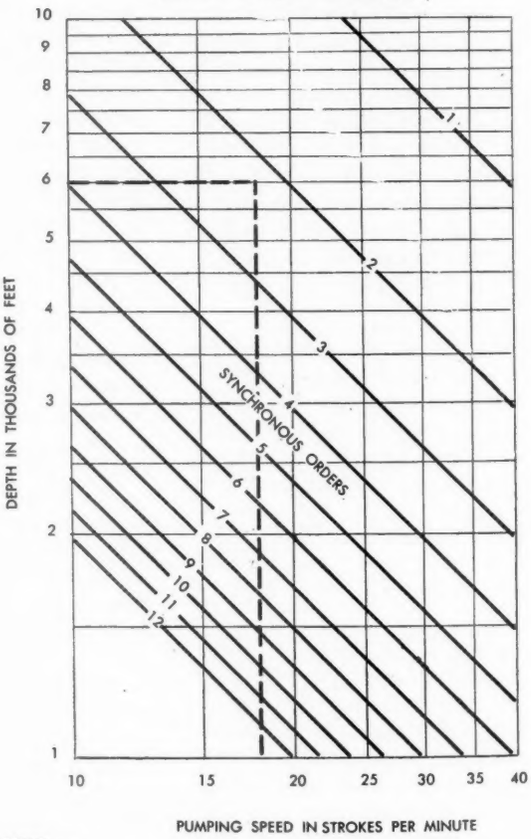
EXAMPLE—
Given: Polish rod displacement = 1136 in./min. Stroke length = 64 in.
Determine: Pumping speed. Result: 17.7 or 18 SPM.

FIG. 2. Length of stroke.



EXAMPLE—Given: Stroke length = 64 in.
Determine: Max. speed permitted by rod fall. Result" 23 SPM.

FIG. 3. Graph of stroke length and spm permitted by fall based on 70 per cent of maximum free fall limit.



EXAMPLE—
Given: Pump depth = 6000 ft. Pumping speed = 18 SPM.
Determine: Order of synchronization. Result: Between 2nd and 3rd orders.

FIG. 4. Pumping speeds which are synchronous and non-synchronous with the natural frequency of vibration of different lengths of sucker rod strings.

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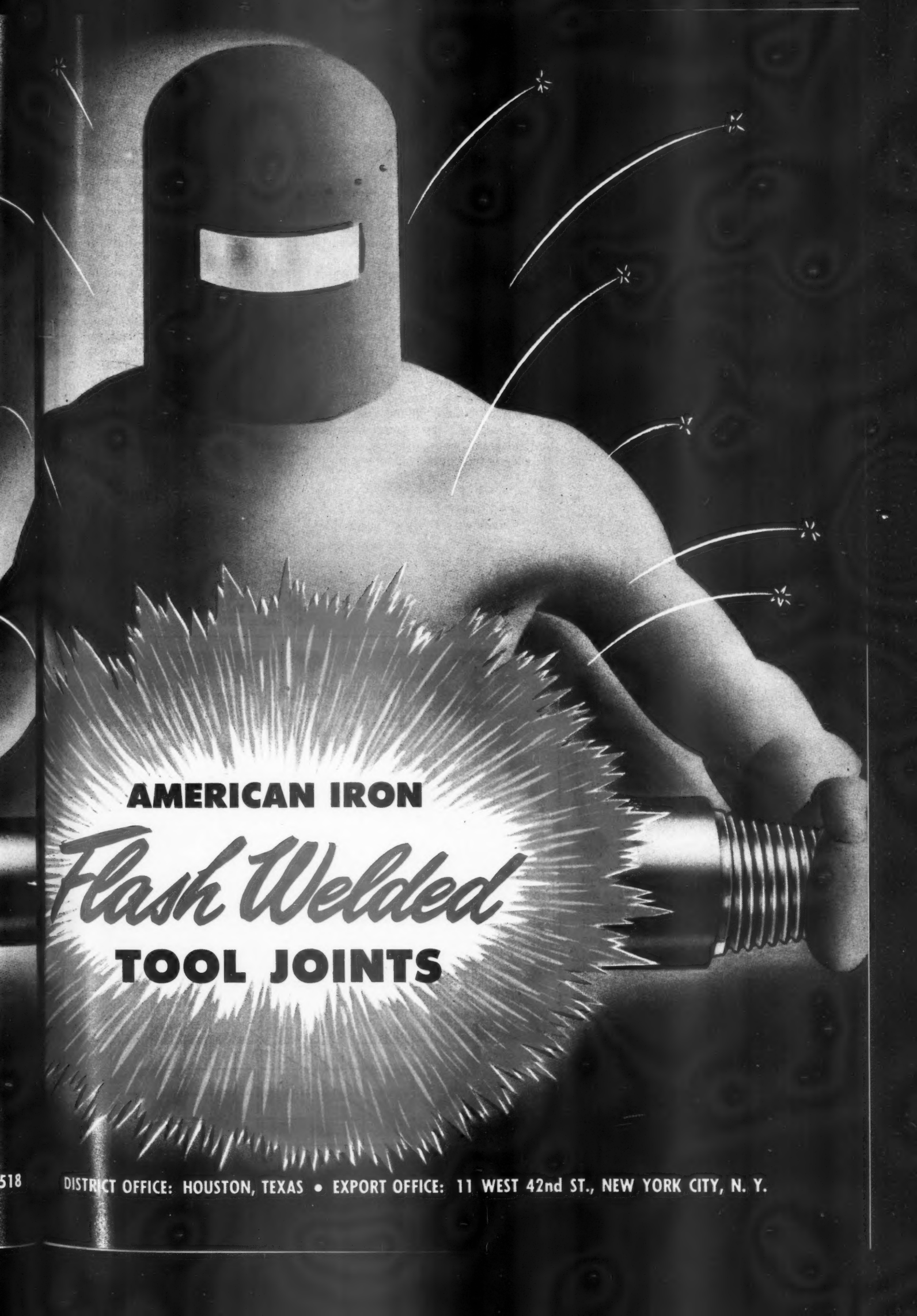

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Pumping Unit Selection

There are four factors to be considered in selecting a unit to fit a specific well. First, the maximum load rating; second, the peak torque rating; third, the counterbalance necessary for maximum conditions; and fourth, the length of stroke that can be obtained with the unit.

Peak Load. The beam rating of a unit determines the allowable beam stresses, bearing loads, and pitman loading. The maximum load rating is based upon API specifications for allowable working stresses of the beam and bearings that are designed for carrying the maximum load.

The peak load is determined by use of Mills' formula in which the dead fluid load is not accelerated. This formula is as follows:

Peak load = Weight of fluid + (weight of rods × Mills' acceleration factor,) or =

$$W_f + W_r\left(1 + \frac{LN^2}{70500}\right) \text{ lb}$$

W_f = Static fluid load, lb
W_r = Static rod load, lb
L = Polished rod stroke, in.
N = Strokes per minute

Peak Torque. A variation of Mills' formula is used to estimate the peak torque in which the fluid is not accelerated. In this, it is assumed that 60 per cent of the peak load is counterbalanced. The formula is:

$$.4\left[W_f + W_r\left(1 + \frac{LN^2}{70500}\right)\right]\frac{L}{2} \text{ in.-lb}$$

This formula gives fairly close approximations to measured loads and peak torque calculated from measured loads.

Fig. 14 gives a quick method of estimating peak torque when the accelerated upstroke load is known.

Counterbalance. Proper counterbalance results in the following advantages: Smaller units and prime movers may be used, life of the equipment is prolonged, repairs are reduced, and power demand is lowered.

"Actual" counterbalance is the actual load of the counterbalance weights used, while effective counterbalance is the counterbalancing result that the weights exert. The ideal effective counterbalance on beam-balanced wells is estimated as the dead or static rod load plus one-half the fluid load. The net load under these conditions should be equal for both the upstroke and the downstroke. In actual practice, however, so many factors enter into the calculation of counterbalance that, in most cases, ideal results cannot be obtained. Estimation for maximum expected conditions should be used, therefore, and the unit should be balanced more accurately after installation by use of instruments or by slipping the clutch. The effective counterbalance on beam-balanced wells depends upon the speed. On rotary-counterbalanced wells, the effective counterbalance is independent of the operating speed.

As well characteristics change with age, a constant check of counterbalance is necessary, so as to keep the equipment operating correctly.

FIG. 5. Mills acceleration factor.

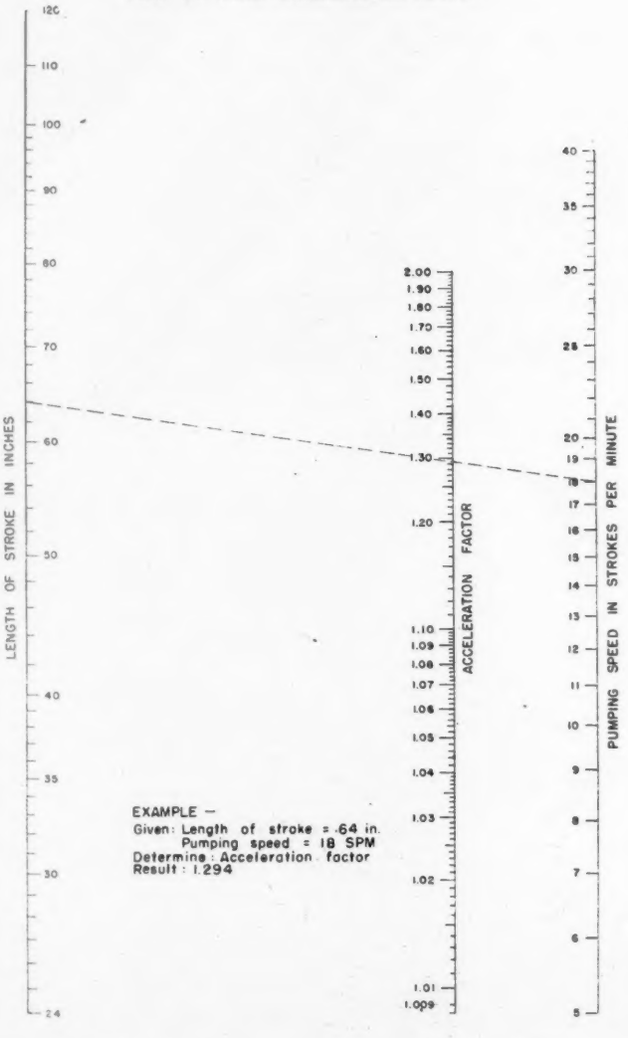
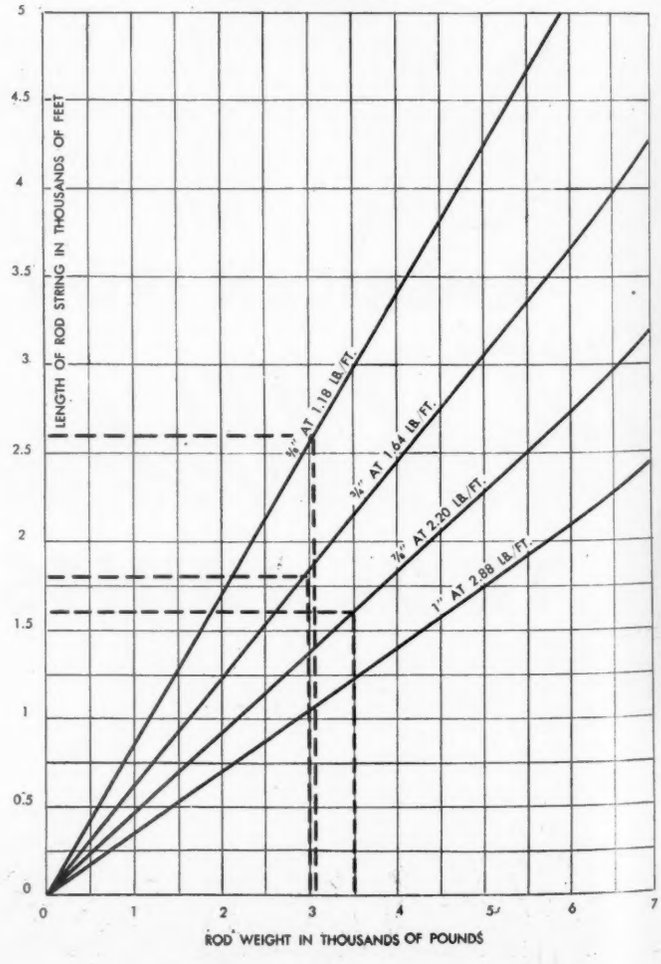
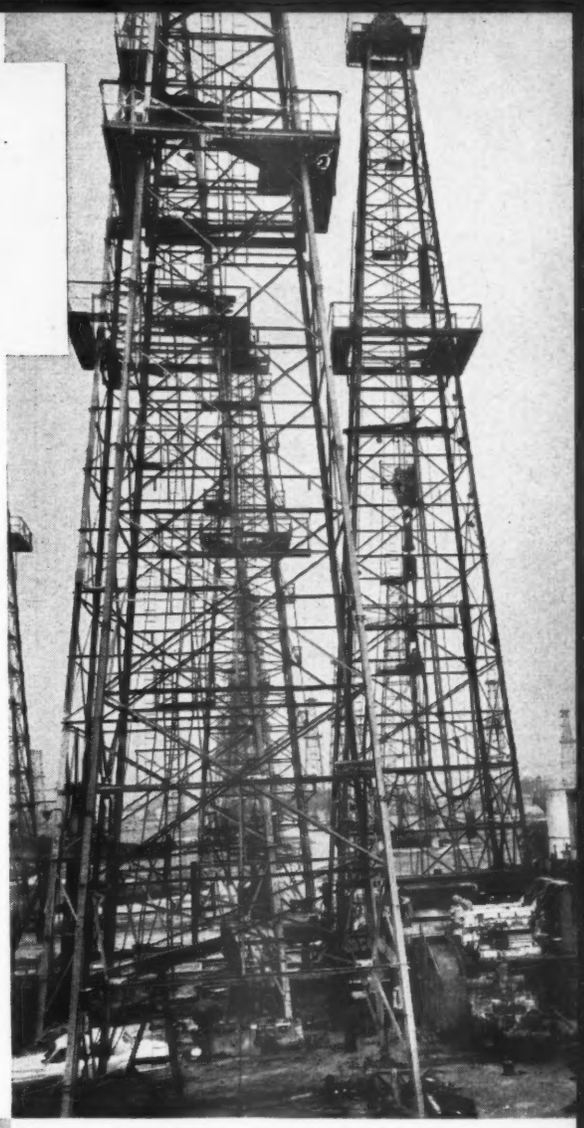

LENGTH OF STROKE IN INCHES
ACCELERATION FACTOR
PUMPING SPEED IN STROKES PER MINUTE
EXAMPLE —
Given: Length of stroke = 64 in.
Pumping speed = 18 SPM
Determine: Acceleration factor
Result: 1.294

FIG. 6. Rod weight.

EXAMPLE—
Given: Length of 7/8" rod = 1600 ft.
Length of 3/4" rod = 1800 ft.
Length of 5/8" rod = 2600 ft.
Determine: Weight of each size rod.
Result: 7/8" rod = 3500 lb.
3/4" rod = 2960 lb.
5/8" rod = 3070 lb.


LENGTH OF ROD STRING IN THOUSANDS OF FEET
7/8" AT 1.18 LB./FT.
3/4" AT 1.64 LB./FT.
7/8" AT 2.20 LB./FT.
1" AT 2.88 LB./FT.
ROD WEIGHT IN THOUSANDS OF POUNDS

ENGINES
WITH AN 8000-FOOT REACH

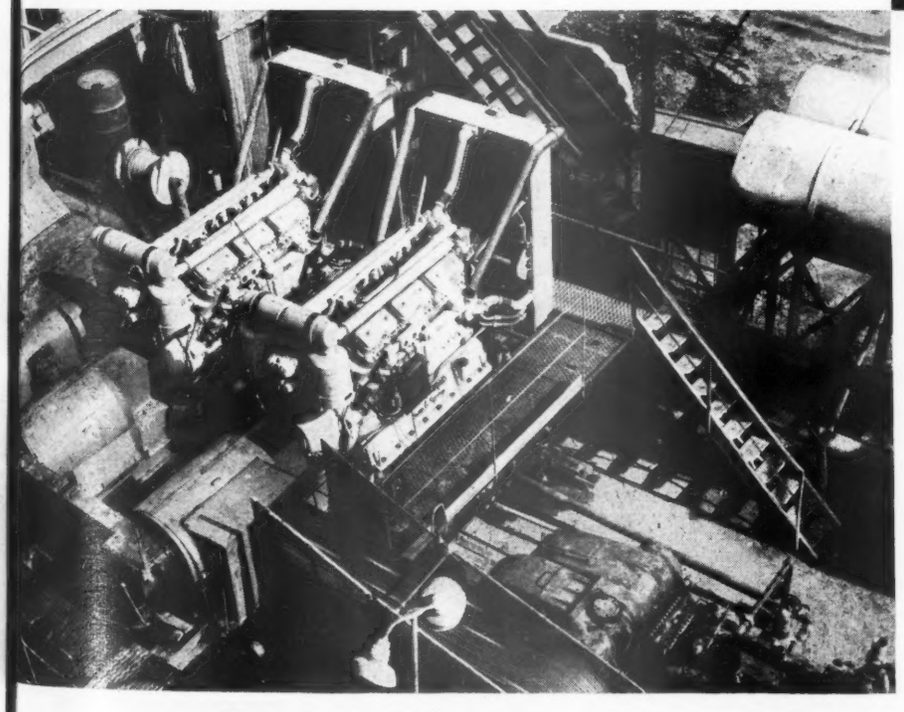


DRILLING results 8000 feet down depend upon the power driving your rig. That's why so many oilfield men prefer "Caterpillar" Oilfield Engines. They're built to give longer service; they deliver their horsepower without straining their innards; and they're easy to move —an important consideration.

Here two D397 "Cat" Oilfield Engines are compounded to make hole for The Hathaway Co., Santa Fe Springs, California. They power a Wilson Titan Model Rig, and a No. 20P Oil Well mud pump. It's a redrilling job at the Hathaway Springs No. 6 well, so they're milling a window in the old casing at 3600 feet, where the old well was cemented off. New hole will go to 8000 feet. Down there, and getting there, the power up top has got to be ample and dependable.

"Cat" Oilfield Engines give that assurance. They're made of extra-quality materials, and their durability and performance cut down-time to the bone to make their over-all cost rock-bottom. With "Caterpillar" Engines and machines, you know that parts and servicemen will be there when you need them. Ask your "Caterpillar" dealer to *show* you what these sturdy yellow engines can do.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS



LOOK UNDER THE HIDE

"Caterpillar" intake and exhaust valves are made of highly alloyed, heat-resistant steels. Their ample size and close machining and heat-treat specifications have resulted in thousands of hours of trouble-free valve operation. Valve and rocker arm design are matched to reduce wear. Valves in the D397, D386, D375 and D364 Engines have special hard facings on contact surfaces—and have valve rotators and hardened valve seat inserts to reduce wear. Look under the hide for long-life quality features.

CATERPILLAR

REG. U. S. PAT. OFF.

OILFIELD ENGINES

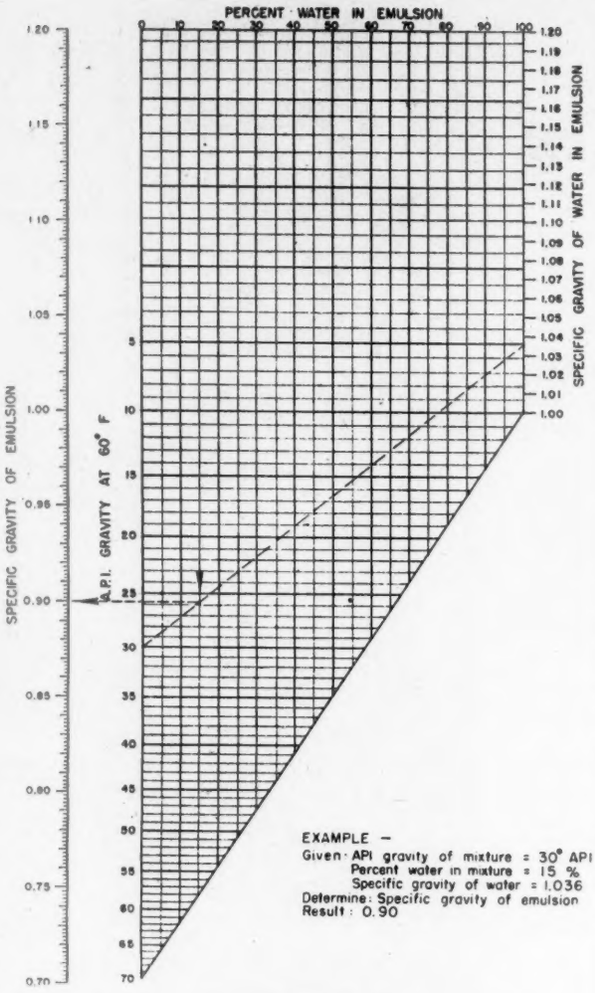

PERCENT WATER IN EMULSION
SPECIFIC GRAVITY OF EMULSION
A.P.I. GRAVITY AT 60° F
SPECIFIC GRAVITY OF WATER IN EMULSION
EXAMPLE —
Given: API gravity of mixture = 30° API
Percent water in mixture = 15 %
Specific gravity of water = 1.036
Determine: Specific gravity of emulsion
Result: 0.90

FIG. 7. API gravity and specific gravity of oil and water mixtures.

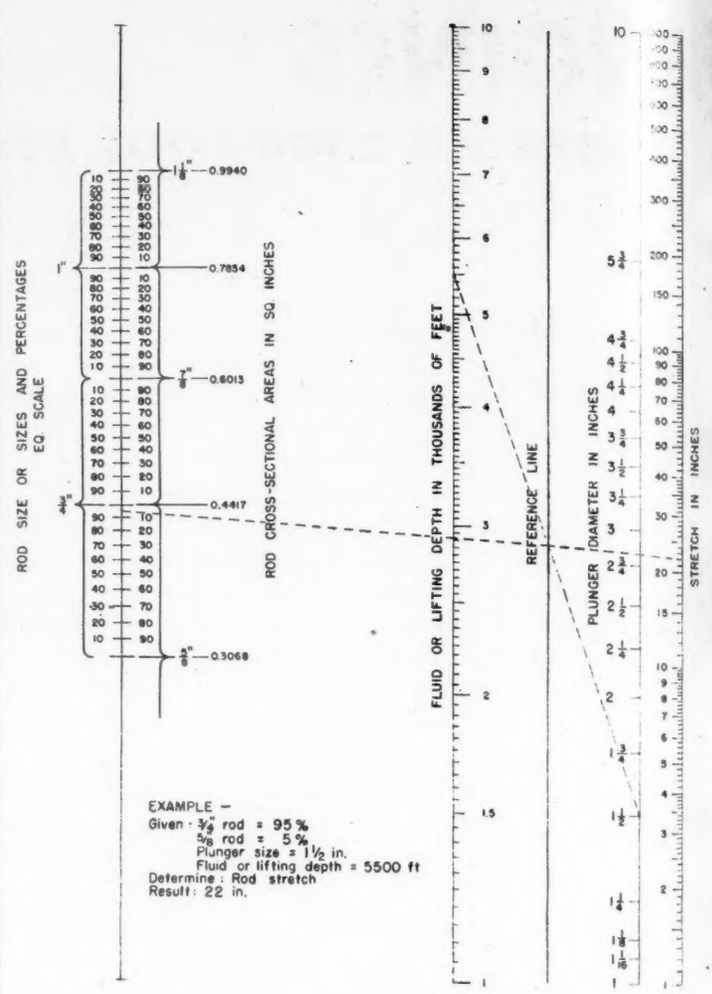


FIG. 9. Three and four-way rod combination conversion scale. Sucker rod stretch single and 2-way strings.

Selection of Prime Mover

Calculation of Horsepower. In making calculations of the power necessary to lift and produce a certain amount of fluid, the first step is usually a calculation of the hydraulic horsepower necessary to lift a given amount of fluid from a certain depth. It is assumed that no help from gas exists and that a dead fluid is being lifted. The formula for this is:

$$\text{Hydraulic horsepower} = \text{Bbl of fluid per day} \times \text{wt per bbl} \times \frac{\text{lift (or depth to pump)}}{33{,}000 \times 60 \times 24}$$

$$= \frac{\text{BPD} \times \text{wt per bbl} \times \text{lift}}{47{,}520{,}000}$$

Where: The lift is determined from fluid level measurements, bottom hole pressure, and productivity indices.

The load on the prime mover may vary considerably over the life of the well, and, when using a gas engine, the engine should be selected so that the horsepower output can be varied for maximum and minimum conditions if possible.

Selection of Single Cylinder Engine. To determine the required brake horsepower for a single cylinder engine, the hydraulic horsepower is divided by the overall efficiency. The overall efficiency is obtained by combining the above-ground, or unit efficiency, and below-ground efficiency. Although the below-ground efficiency may be higher in shallow wells and lower in deep wells, the average below-ground efficiency generally used in calculations is 50 per cent. The efficiency of most pumping units in operation today is generally assumed to be 80 per cent. The above two efficiencies result in an overall efficiency of 40 per cent. Therefore, to determine the required rating of a single cylinder engine, multiply the hydraulic horsepower by 2.5 (or divide by 0.40). Having determined the "Required Brake Horsepower" at the selected speed and stroke for maximum conditions, the next step is to select the engine. The single cylinder engine should be selected so that the required brake horsepower lies between 50 and 90 per cent (preferably nearer 90 per cent) of the manufacturers' maximum recommended speed.

Selection of Multi-Cylinder Engines. Because of the small amount of flywheel effect on multi-cylinder engines, an engine that is rated higher than a single cylinder engine may be necessary to carry the unit through points of high torque demand. To determine the required brake horsepower of a multi-cylinder engine, multiply the hydraulic horsepower by three (3). This application factor also takes into account the overall efficiency as discussed above under single cylinder engines.

The API rating, which is 65 per cent of the power unit maximum horsepower, should be used in selecting a multi-cylinder engine. The multi-cylinder engine should be selected so that the required brake horsepower as calculated above appears at 1000 rpm or at the manufacturer's maximum recommended speed, whichever is the lesser speed. The bmep should be about 65 psi.

(Continued on Page 36)

Baash-Ross News

BAASH-ROSS TOOL COMPANY • LOS ANGELES • HOUSTON • OKLAHOMA CITY • NEW YORK

OUR 30th YEAR

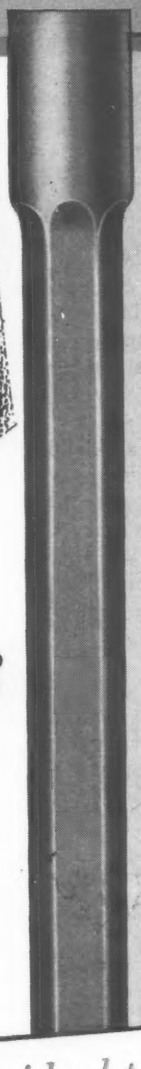
Hex Kellys give the Most in PERFORMANCE FEATURES

and BAASH-ROSS GIVES THE MOST IN HEX KELLYS!

The Hexagon Kelly has become firmly established among performance-minded oil men as the *best* all-around kelly for modern drilling operations. It is not only easier to keep straight, is stronger, has greater circulation area, and incorporates many other important features (as highlighted at right) . . . but, in addition, it can be used for *both* regular and pressure drilling operations without change. This added feature greatly simplifies equipment inventories and also saves vital time when pressure emergencies occur — both advantages of utmost importance!

And Baash-Ross is the organization that, from the very beginning, has consistently led in the development of the Hexagon Kelly . . . in the development of better metallurgical and heat treating processes for incorporating the best *balance* of physical properties into Baash-Ross Hexagon Kellys . . . in the development of better machining techniques to insure a straighter bore, better joint alignment, more uniform wall thickness and other advantages in *Baash-Ross* Hexagon Kellys.

Result — when you combine the natural advantages of Hexagon Kellys with the *added* advantages of Baash-Ross manufacturing and control techniques you get a new standard of kelly performance when you specify *Baash-Ross Hexagon Kellys!*



These are the NATURAL ADVANTAGES of Hexagon Kellys . . .

- **SMOOTHER RUNNING** — because they are *machined* — not forged — to shape, hence have closer tolerances, better balance!
- **GREATER RESISTANCE TO BENDING** — because even across their weaker axis they are 17½% more resistant to bending than the comparable size square kelly across its *stronger* axis!
- **36% MORE CIRCULATION AREA** — because of greater cross-sectional area. Particularly vital with today's full-hole pipe and high-volume pumps!
- **24% STRONGER IN TORQUE** — because of their shape and greater cross-section. Doubly important with today's longer strings, higher rotational speeds!
- **GREATER TENSIONAL STRENGTH** — because of more cross-section. A valuable feature with today's heavier strings!
- **MAXIMUM ADAPTABILITY** — because they can be used for *both* regular and pressure drilling *without* change. Simplifies inventories, saves vital time in pressure emergencies!

These are the ADDED ADVANTAGES You Get in BAASH-ROSS Hexagon Kellys!

- **BEST BALANCE** of shock-resisting *toughness* and wear-resisting *hardness* resulting from the exclusive Baash-Ross method of subjecting specially-selected alloy steels to multiple *full-length* heat-treatments that develop the metallurgical properties of the steel for both hardness and toughness.
- **UNUSUALLY ACCURATE BORE**, exactly centered end-to-end and then individually checked by special survey equipment.
- **PRECISE JOINT ALIGNMENT**, double-checked by the Baash-Ross Alignoscope, assures concentric rotation and freedom from joint failures.
- **PLUS EQUALLY RIGID CHECKS** on overall straightness . . . on thread form, taper, lead and finish . . . on dimensional accuracy of drive faces, upsets, etc. . . checks that meet all API specifications as well as extremely close Baash-Ross specifications.

The ideal teammate for Baash-Ross Hex Kellys . . .

the BAASH-ROSS HEX ROLLER KELLY BUSHING

All the advantages of roller bushing performance—plus vital quick-adjustment feature!

When you adopt Hex Kelly equipment, be sure to get the utmost in Hex Kelly performance by driving your kellys with a Baash-Ross Hex Roller Kelly Bushing—*the Bushing especially designed for use with hexagon kellys!*

Not only does this Bushing provide all the well-known advantages of Baash-Ross Roller Kelly Bushings . . . instant friction-free response to bit feed, better control of weight, more footage per bit, longer equipment life and higher all-around drilling efficiencies . . . *but it also permits quick adjustment to provide the close fit so essential for maximum Hex Kelly performance.*

The narrower driving faces on Hex Kellys make it vitally important that a close fit be maintained between the Bushing and Kelly at all times.

In the Baash-Ross Kelly Bushing this adjustment is readily made by simply adding or removing Adjusting Shims in the body. Each set of Shims added or removed changes the working diameter by exactly 1/32", making close adjustment a quick, simple operation. (See page 416 of your 1950 Composite Catalog for further details on this vital adjustment feature!)

FOR: • Greater Footage per Bit • Greater Freedom from Twist-Offs • Smoother, Faster Drilling • Longer Kelly and Equipment Life standardize on Baash-Ross Hexagon Kellys driven by Baash-Ross Hex Roller Kelly Bushings . . . *the perfect combination for maximum drilling efficiency!*

BAASH-ROSS KELLYS ARE AVAILABLE THROUGH LEADING SUPPLY STORES

Selection of Electric Motors. An electric motor is selected on the same bases as a multi-cylinder engine; i.e., the hydraulic horsepower is multiplied by an application factor to determine the motor horsepower rating required. The application factor will vary from 2 to 5 depending on well conditions, power factor, etc.

Selection of Sheaves

Centrifugal force becomes critical at speeds of more than 4000 feet per minute and has a tendency to throw V-belts away from the sheave grooves. Because of this, increased tension becomes necessary. This, in turn, reduces belt life and gives the belts a lower horsepower rating per belt.

The unit manufacturers usually supply data on size, type, and number of grooves, for a particular unit. As they also furnish the gear ratio, the only factors left for consideration are the rpm at which the engine is to be operated, and the spm at which the unit is to be operated.

Fig. 16 gives all these factors and from it can be determined either the engine or unit sheave size when the other factors (rpm-spm-Gear Ratio) are known.

The type section such as A, B, C, D, or E, and the number of grooves is given by the unit manufacturer, however, if further information is desired as to speed ratios, belt lengths, center distances, belt velocity, arc of contact, load application factors, etc., it is obtainable at request from various V-belt and sheave manufacturers.

Dynamometer Work

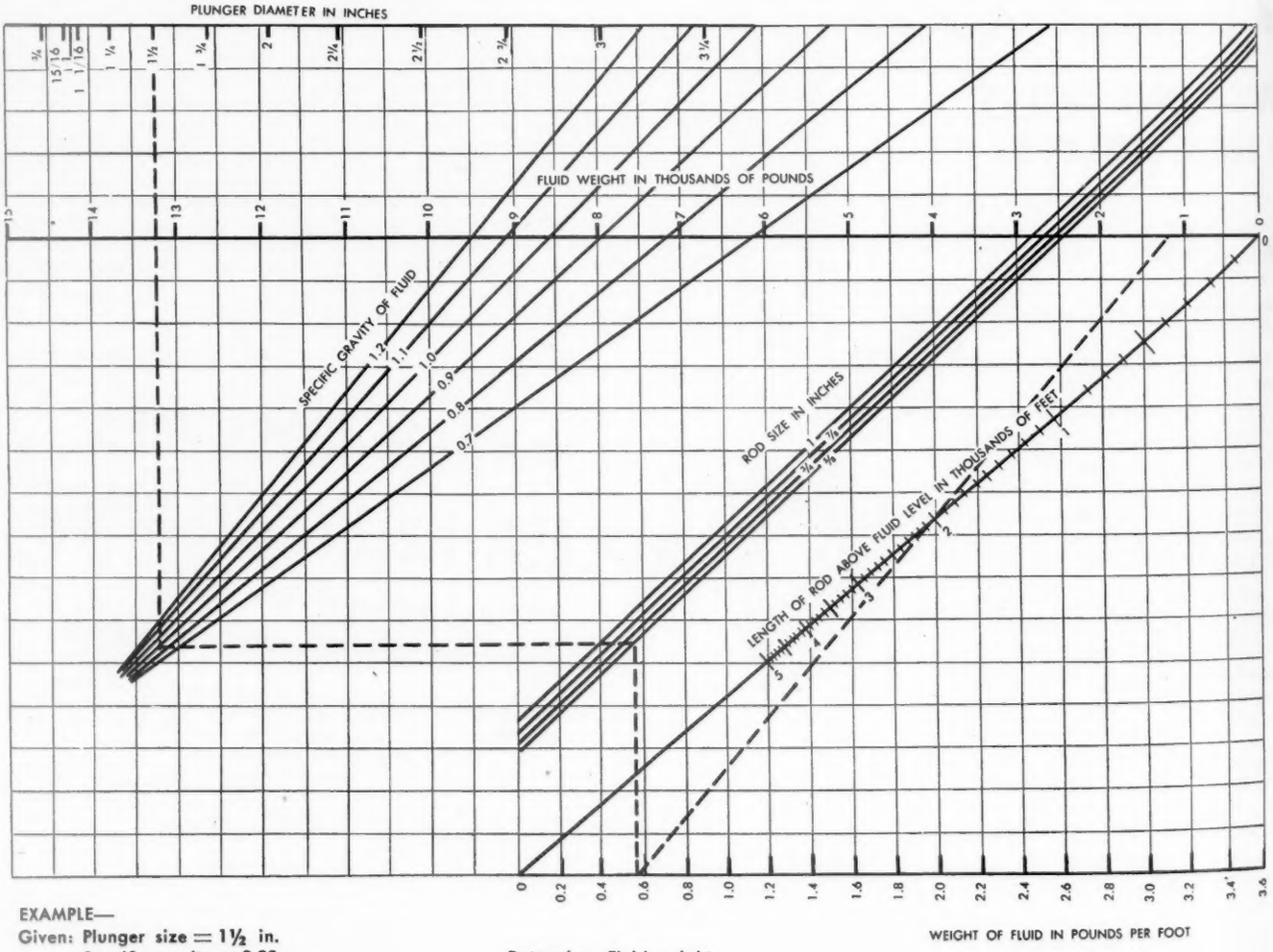
Dynamometer work on comparable wells will give valuable data for design and selection of pumping equipment, and should be obtained where possible to supplement theoretical work.

The first wells in a new area should be analyzed and weighed with a dynamometer after they are put on the pump in order to check the theoretical work. A periodic check with a dynamometer made at about 6-month intervals will detect changes in well characteristics and detrimental conditions that may have developed.

Procedure for Design and Selection

The outline given below will give the steps to follow in the design and selection of equipment for a complete rod-pumping installation. Data Sheets 1 and 2 are provided so as to simplify the tabulation of the data necessary for the selection of pumping equipment.

1. Assume several plunger sizes and an overall efficiency. This overall efficiency is equal to the liquid produced divided by the pump displacement based on polished rod travel, and therefore takes into consideration losses due to rod stretch, tubing stretch, pump efficiency, and gains due to overtravel. The overall efficiency assumed will depend on the well characteristics, pump setting depth, fluid level, etc. With shallow wells (under 5000′) the efficiency can usually be assumed to be 60-65 per cent, for deep wells 50-55, and for agitating pumpers 100 per cent or better.


PLUNGER DIAMETER IN INCHES
FLUID WEIGHT IN THOUSANDS OF POUNDS
SPECIFIC GRAVITY OF FLUID
ROD SIZE IN INCHES
LENGTH OF ROD ABOVE FLUID LEVEL IN THOUSANDS OF FEET
WEIGHT OF FLUID IN POUNDS PER FOOT

EXAMPLE—
Given: Plunger size = 1½ in.
Specific gravity = 0.90
Rod size = ⅝ in.
Length: ⅝″ rod above fluid level = 2100 ft.

Determine: Fluid weight.
Result: 1190 lb
Example shows only portion of string for clarity.

FIG. 8. FLUID WEIGHT NOMOGRAPH.

Quality Pays Off!

When your well calls for long-stroke pumping . . . with thousands of feet of tubing above your subsurface pump . . . anything less than the best is poor economy! That's when you need the advanced engineering and precision workmanship of . . .

Illustrated above is a Neilsen 2½" x 2¼" x 30' I-R Metal Sectional Liner Barrel Tubing Pump being run in a 5,779' well located near Brookhaven, Mississippi. This pump is equipped with a 5' I-R Metal Plunger of .003 fit. There are 5,737' of tubing above this pump, which is being operated with a 246" stroke at 8 S.P.M. to produce an average of 900 to 1000 bbls. total fluid per day, of which 135 bbls. per day is oil.

Neilsen Long-Stroke Pumps for Installation ANYWHERE

WHEN it was first realized that long-stroke hydraulic pumping units offered distinct advantages in pumping deep wells, Neilsen Pump Division of Oil Well Supply Company, installed suitable equipment for honing pump barrels of extreme lengths . . . so that the many exclusive quality features of Neilsen I-R Metal Sectional Liner Streamline-Flow Subsurface Pumps would be available for these deep-well pumping applications, where quality is so important.

In the past, applications of long-stroke pumps have, because of the transportation problems involved, been restricted to easy-to-reach locations near the factory.

Now . . . a means has been perfected whereby extra long Neilsen I-R Metal, Sectional Liner Barrel, Tubing Pumps . . . such as the 30' barrel shown at the left . . . can be transported in two pieces and reconnected at the well site; retaining the exact "factory honed" alignment. This makes it possible to ship these quality pumps to the most remote locations without endangering their performance.

MORE AREA · LESS FRICTION · MORE VOLUME

Neilsen I-R Metal Sectional Liner Barrel Tubing Pumps, combine high strength, corrosion resistance and low turbulence. They have standard A.P.I. dimensions and are equipped with streamlined fittings. I-R Metal is extremely hard, excellent in corrosion resistance, and has a very low coefficient of friction. Neilsen I-R Metal Plungers can be operated against I-R Barrels without seizing—thus avoiding temperature difficulties and making this the most outstanding Subsurface Pump material known.

If you have a long-stroke pumping problem let one of "Oilwell's" skilled Subsurface Pump Representatives, assist in selecting and running the Neilsen long-stroke pump that will give maximum performance and service in your well—regardless of location.

OIL WELL SUPPLY COMPANY

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Division Offices—CASPER, WYOMING
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USS "OILWELL"

UNITED STATES STEEL

Divide the expected future production by the assumed efficiency and use the results to determine the polish rod displacement for each assumed plunger on Fig. 1.

2. Use the polished rod displacements obtained from Fig. 1 to select pumping speeds and stroke lengths on Fig. 2.

3. Consult Fig. 3 to determine whether the assumed pumping speeds are practical for the stroke lengths. If the pumping speed is greater than the practical limiting speed shown on the graph, another combination of stroke and pumping speed will have to be selected.

4. Consult Fig. 4 with the pump setting depth and pumping speed to determine whether the speed is of a synchronous order. If the point determined falls on a synchronous order line, another speed must be assumed.

5. Select a sucker rod string. See information on Sucker Rod Types in the Appendix to determine the type of rod to use. Tables 1 through 10 may be used as a guide in the preliminary selection of the rod string. It must be remembered, however, that for conditions other than those stated, the limiting depth of the string will differ from those given in the tables. For final selection of the rod string, the accelerated upstroke load will have to be checked against the endurance limit of the rod string.

6. Determine the per cent of each size rod in the rod string on Table 11.

7. Multiply the total rod string length by the per cent of each size rod to find the footage of each size rod in the string. Adjust the footages for rod lengths.

8. With the footage of each size rod in the string, consult Fig. 6 to determine the weight of each section. Total these weights to obtain the total static weight of the rod string.

9. Use the API gravity of the oil and the per cent and specific gravity of the water in the fluid to find the specific gravity of the fluid on Fig. 7.

10. With the plunger size, specific gravity, rod size, and the length of each size rod above the fluid level, consult Fig. 8 to find the fluid weight for each rod section. Total these weights to obtain the total fluid weight.

11. Find the acceleration factor on Fig. 5 using the length of stroke and the pumping speed.

12. Multiply the total static rod weight by the acceleration factor to determine the accelerated rod load.

13. Add the accelerated rod load to the fluid load to determine the accelerated upstroke load.

14. Check the accelerated upstroke load with the endurance limits of the

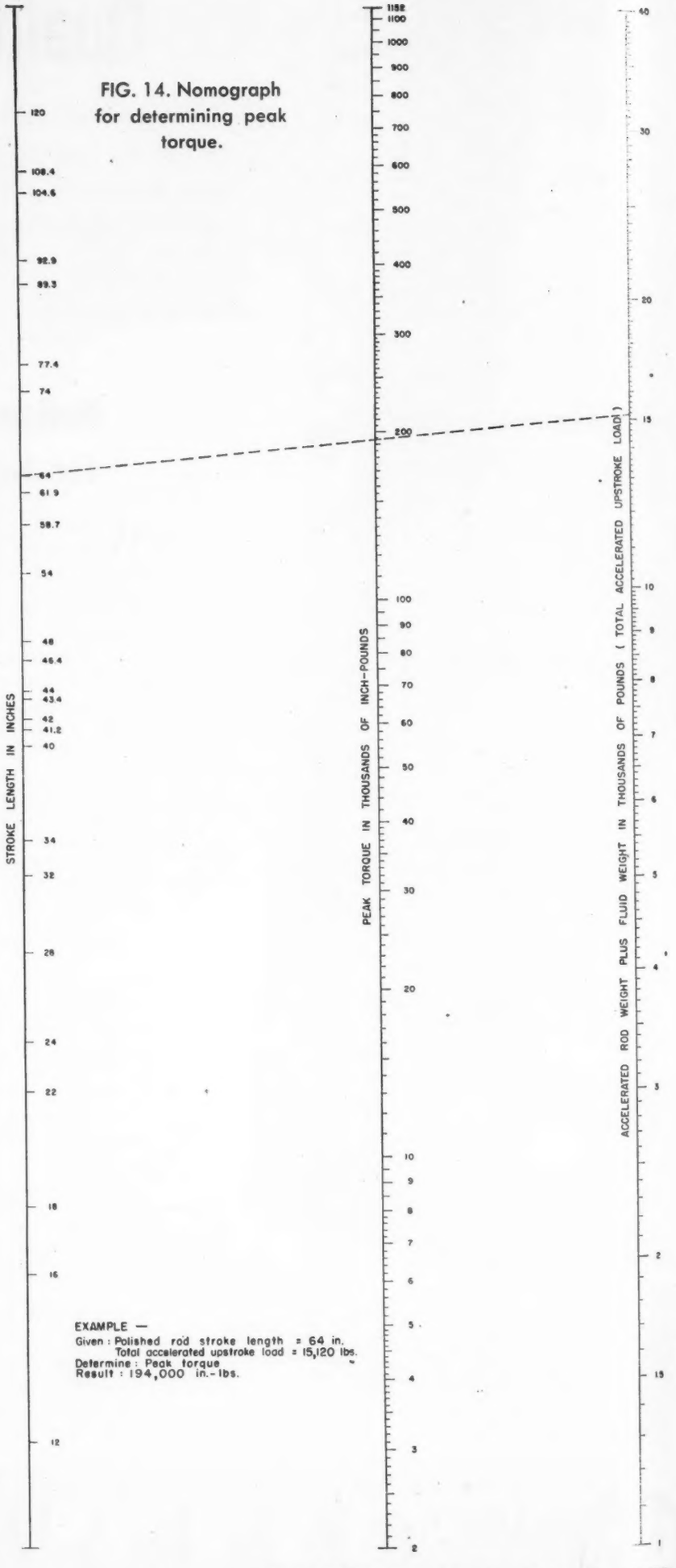
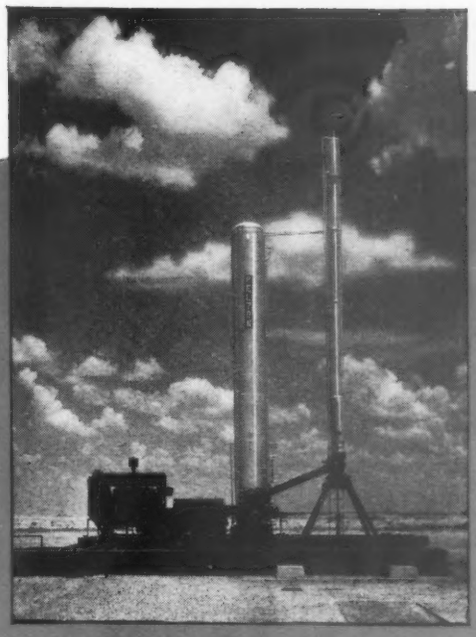


FIG. 14. Nomograph for determining peak torque.



PELTON Jacks are available in 7 models with polished rod load ratings from 20,000 to 40,000 pounds. Stroke lengths 20, 25 and 30 feet.

OIL PRODUCTION DOUBLED* WITH PELTON LONG STROKE Hydraulic Pumping Jacks

PRODUCTION CALCULATIONS
SHORT STROKE VS PELTON LONG STROKE
Equal Polished Rod Travel

	Short Stroke	Long Stroke
Upward Polished Rod Travel	740 in. per min.	740 in. per min.
Surface Stroke Length	74 in.	360 in.
Strokes per Minute	10	2.05 (A)
Pump Setting	8400 ft.	8400 ft.
Bottom Hole Pump Plunger Diameter	1¾ in.	1¾ in.
Acceleration Factor (Mills Formula)	1.104	1.021
Peak Polished Rod Load	26,437 lbs.	24,986 lbs.
Maximum Stress in Top Sucker Rod	33,677 psi.	31,829 psi.
Sucker Rod Stretch	54 in.	54 in.
Bottom Hole Pump Plunger Overtravel	10 in.	2 in.
Net Bottom Hole Pump Plunger Travel	30 in.	308 in.
Per Cent Surface Stroke LOST through Sucker Rod Stretch after Correction for Overtravel	59.5%	14.5%
Production in Barrels per Day at 100% Bottom Hole Pump Volumetric Efficiency	107	225 (A)

* Increased production due to the long surface stroke equals $\frac{225}{107} \times 100 = 210.2\%$

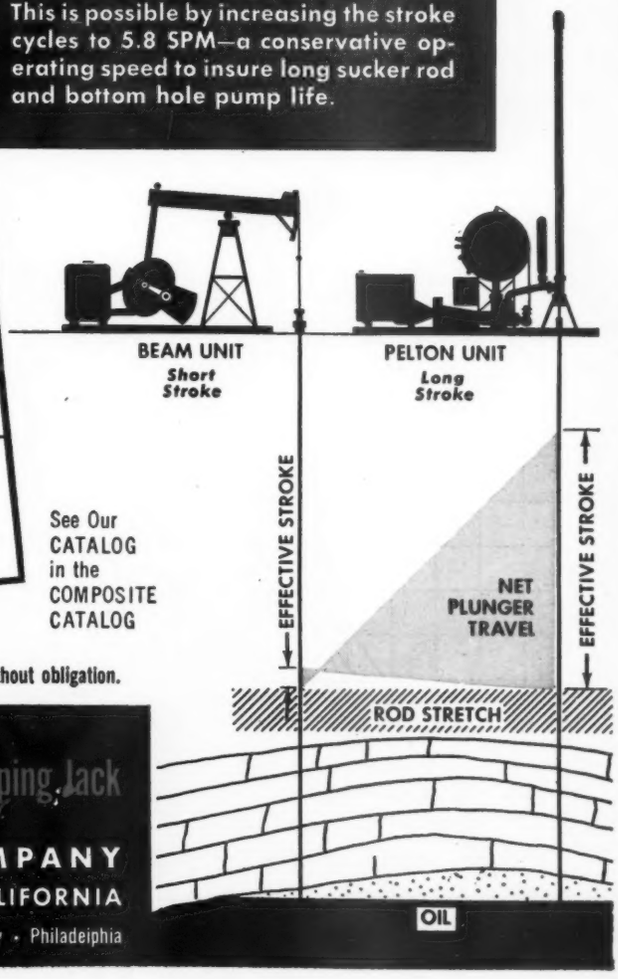
Above calculations based on using a tapered 1", 7/8" and 3/4" Sucker Rod String, 10° API gravity fluid, fluid level at the Pump.

NOTE (A): The 360" stroke Hydraulic Unit may be operated at 5.8 SPM increasing the production to 669 B/D if required, while maintaining satisfactory sucker rod stresses.

IT'S THE EFFECTIVE STROKE THAT COUNTS

The table illustrates how the Hydraulic Long Stroke can double production through minimizing the effect of rod stretch.

As can be seen from note "A," a still further increase in production may be realized with the PELTON Jack without overstressing the sucker rods. This is possible by increasing the stroke cycles to 5.8 SPM—a conservative operating speed to insure long sucker rod and bottom hole pump life.



See Our CATALOG in the COMPOSITE CATALOG

SEND FOR APPLICATION DATA SHEET. Complete recommendations furnished without obligation.

PELTON Long Stroke Hydraulic Pumping Jack

THE PELTON WATER WHEEL COMPANY

2447 EAST 54th STREET • LOS ANGELES 58, CALIFORNIA

District Offices: Los Angeles • San Francisco • Dallas • Houston • New York City • Philadelphia

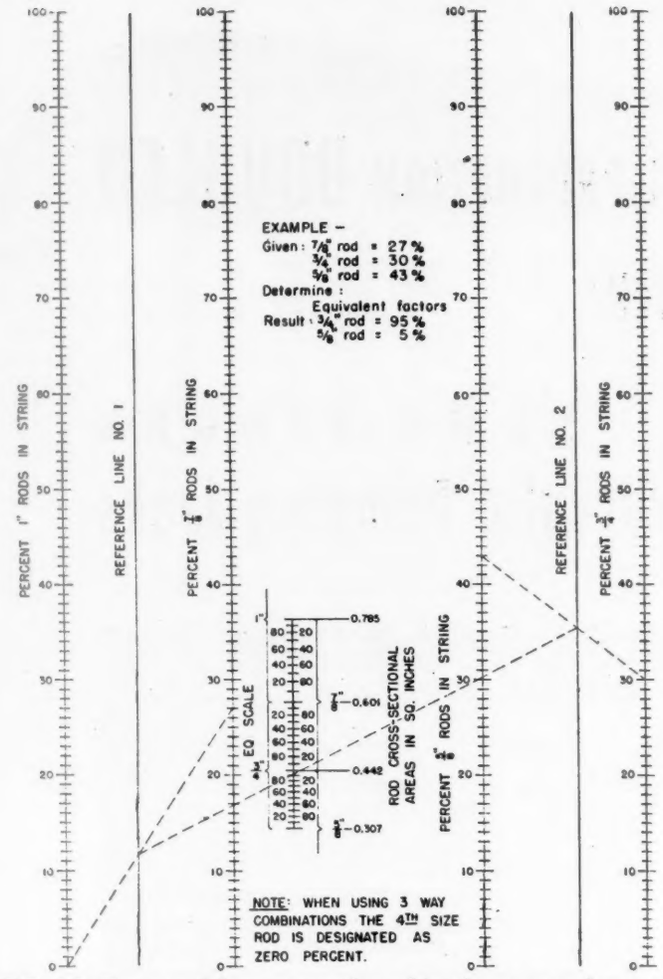

EXAMPLE —
Given: 7/8" rod = 27 %
3/4" rod = 30 %
5/8" rod = 43 %
Determine:
Equivalent factors
Result: 3/4" rod = 95 %
5/8" rod = 5 %
PERCENT 1" RODS IN STRING
REFERENCE LINE NO. 1
PERCENT 7/8" RODS IN STRING
EQ SCALE
ROD CROSS-SECTIONAL AREAS IN SQ. INCHES
0.785
0.601
0.442
0.307
PERCENT 5/8" RODS IN STRING
REFERENCE LINE NO. 2
PERCENT 3/4" RODS IN STRING
NOTE: WHEN USING 3 WAY COMBINATIONS THE 4TH SIZE ROD IS DESIGNATED AS ZERO PERCENT.

FIG. 10. Three and four-way rod combination conversion scale.

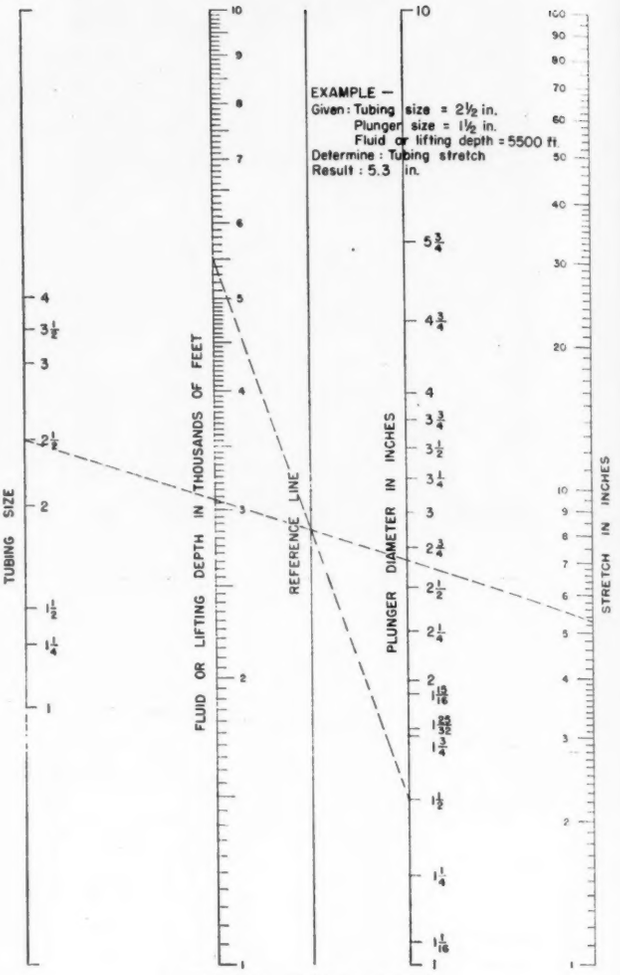
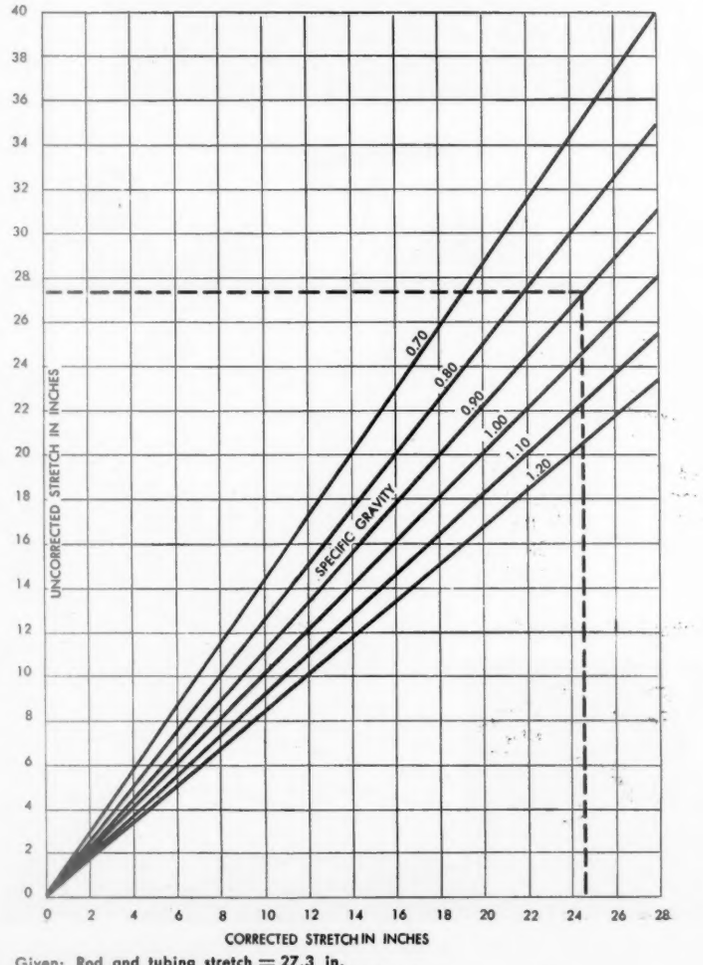
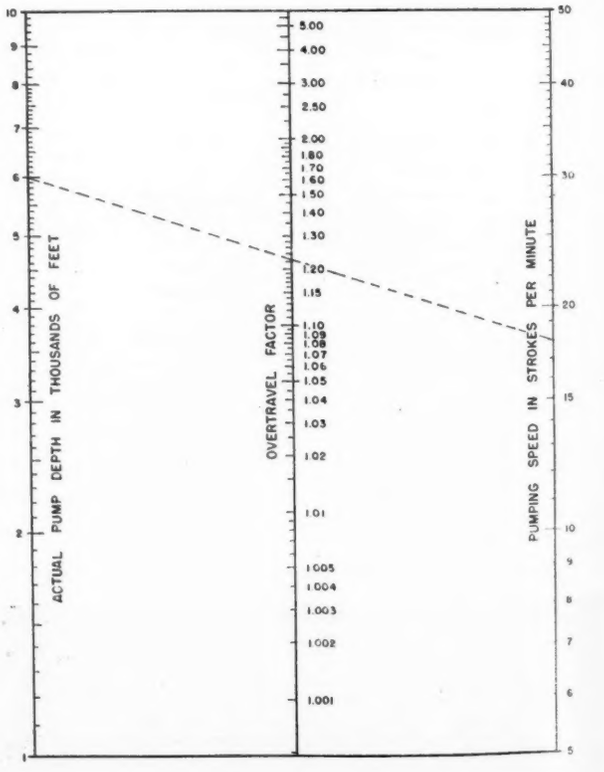

EXAMPLE —
Given: Tubing size = 2½ in.
Plunger size = 1½ in.
Fluid or lifting depth = 5500 ft.
Determine: Tubing stretch
Result: 5.3 in.
TUBING SIZE
FLUID OR LIFTING DEPTH IN THOUSANDS OF FEET
REFERENCE LINE
PLUNGER DIAMETER IN INCHES
STRETCH IN INCHES

FIG. 11. Tubing stretch.



Given: Rod and tubing stretch = 27.3 in.
Specific gravity = 0.90. Corrected stretch = 24.6 in.

FIG. 12. Corrected rod and tubing stretch.



EXAMPLE —
Given: Pumping speed = 18 SPM
Pump depth = 6000 ft.
Determine: Overtravel factor
Result: 1.225

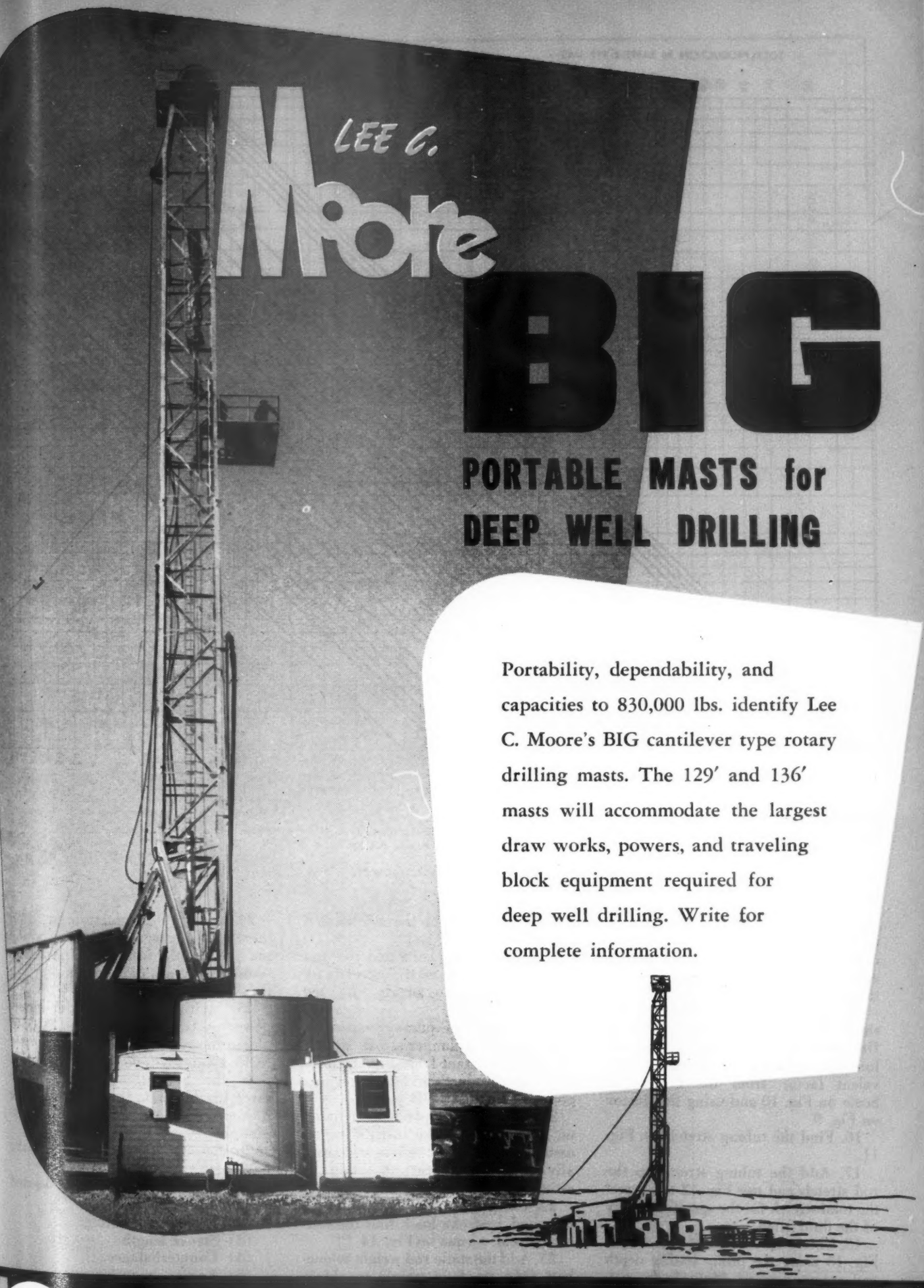
FIG. 13. Overtravel of plunger.

STRETCH IN INCHES

LEE C. Moore

BIG

PORTABLE MASTS for DEEP WELL DRILLING



Portability, dependability, and capacities to 830,000 lbs. identify Lee C. Moore's BIG cantilever type rotary drilling masts. The 129′ and 136′ masts will accommodate the largest draw works, powers, and traveling block equipment required for deep well drilling. Write for complete information.

LEE C. MOORE CORPORATION

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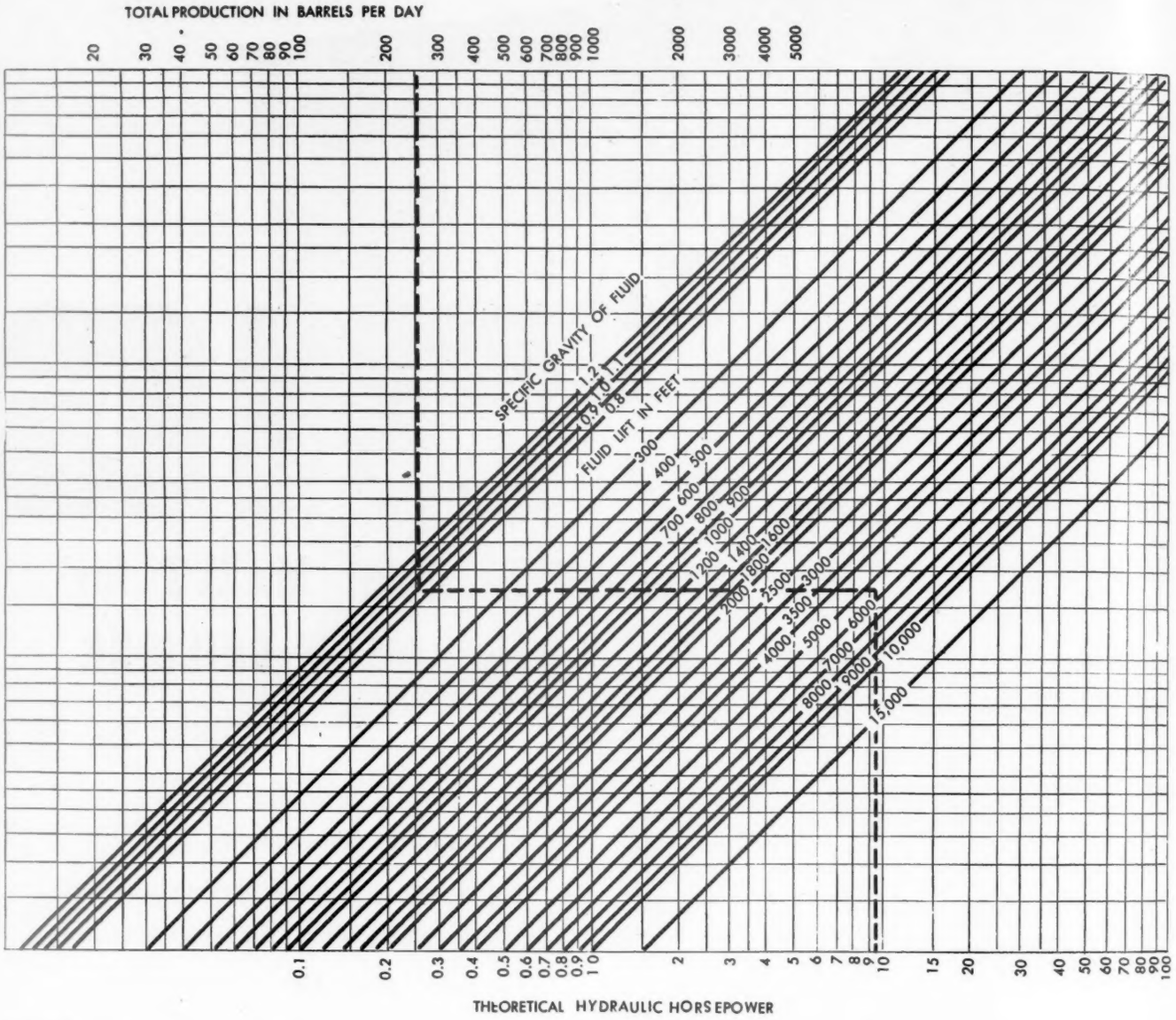


EXAMPLE—
Given: Total max. future production = 254 BPD.
Specific gravity = 0.90. Fluid lift = 5500 ft.
Determine: Theoretical hydraulic horsepower.
Result: 9.4 hp.

FIG. 15. Hydraulic horsepower.

rods in Table 12. If the accelerated upstroke load is greater than the endurance limit in pounds of the largest rod in the string, a larger rod string must be selected.

15. Determine the rod stretch for single and two-way strings on Fig. 9. Determine the rod stretch for three- or four-way strings by obtaining an equivalent factor from the Equivalent Scale on Fig. 10 and using this factor on Fig. 9.

16. Find the tubing stretch on Fig. 11.

17. Add the tubing stretch to the rod stretch and use Fig. 12 to correct the total stretch for the specific gravity of the fluid lifted.

18. Obtain an overtravel factor from Fig. 13 using the pump setting depth and pumping speed. Multiply the polished rod stroke length by the overtravel factor to get the accelerated plunger stroke.

19. Subtract the corrected rod and tubing stretch from the accelerated plunger stroke to obtain the net plunger stroke.

20. Multiply the pumping speed in spm by the net plunger stroke and by the pump constant from Fig. 1 to obtain the production based on net plunger stroke in BPD.

21. Multiply the production based on net plunger stroke in BPD by an assumed volumetric efficiency (usually about 85 per cent) to obtain the estimated production.

22. Using the stroke length and accelerated upstroke load, find the estimated peak torque on Fig. 14

23. Add the static rod weight to one-half (½) the fluid weight to obtain the estimated counterbalance load.

24. Using the production based on the net plunger stroke, the specific gravity, and the feet fluid lift, find the estimated hydraulic horsepower on Fig. 15.

25. Multiply the hydraulic horsepower by two and one-half (2½) to obtain the required brake horsepower for a single cylinder engine or multiply the hydraulic horsepower by three (3) to obtain the required brake horsepower for a multi-cylinder engine.

26. Select a pumping unit on the basis of:

(1) Beam rating (total accelerated upstroke load)
(2) Peak torque rating
(3) Stroke length
(4) Counterbalance
(5) Engine requirements; single reduction for a single cylinder

slow speed engine and double reduction for multi-cylinder high speed engine or electric motor.

27. Select the engine or motor size on the basis of the required horsepower.

28. With the speed of the selected engine in rpm, the unit sheave and gear ratio from the manufacturers' specification, find the engine sheave size on Fig. 16.

29. The above selection of plunger size and rod string was made on the basis of future maximum expected production. It is possible that a smaller plunger and lighter rod string may be used for present conditions. If this is the case, make a complete new set of calculations through Step 21 and re-select a pump plunger size and rod string to be used on the installation.

(Note: When the material included in this report is used to check equipment already installed in operating wells to determine if it is the proper size and operating under the correct conditions, it will be found that many of the steps listed in the instructions above can be omitted due to the exact knowledge that will exist of some of the conditions that would otherwise need to be calculated or assumed.)

FIG. 16. Nomograph for determination of sheave sizes.

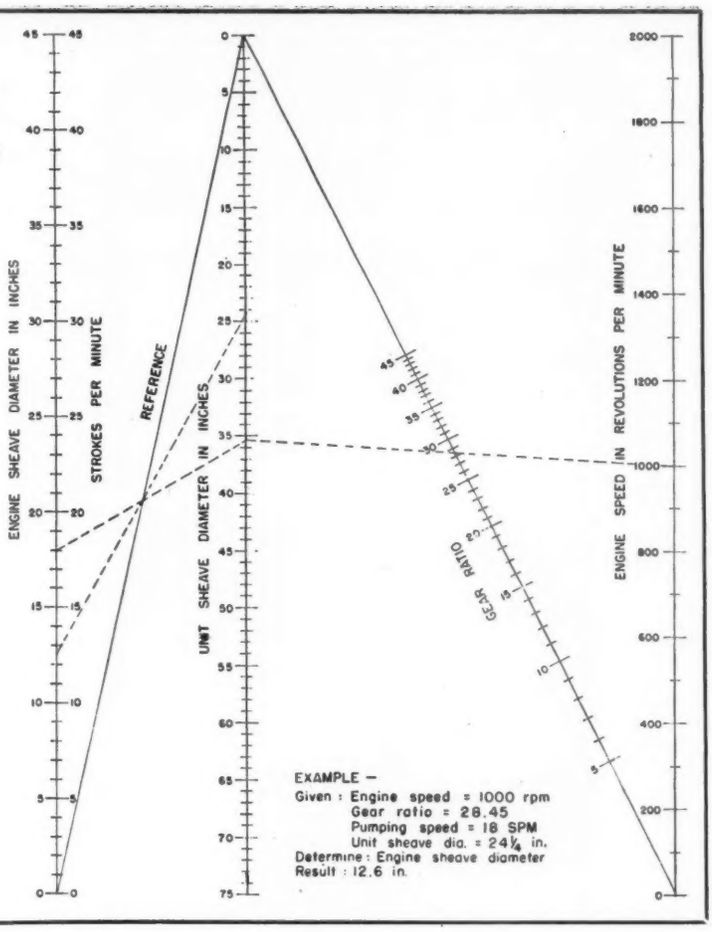

ENGINE SHEAVE DIAMETER IN INCHES
STROKES PER MINUTE
REFERENCE
UNIT SHEAVE DIAMETER IN INCHES
RATIO GEAR
ENGINE SPEED IN REVOLUTIONS PER MINUTE
EXAMPLE —
Given : Engine speed = 1000 rpm
Gear ratio = 28.45
Pumping speed = 18 SPM
Unit sheave dia. = 24¼ in.
Determine : Engine sheave diameter
Result : 12.6 in.

TABLE 1. Carbon steel rods—type 1*—salt water.

Limiting depths of pumps in salt water with various combinations of carbon steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths			¾, ⅞, & 1 in. Comb's. limiting depths		
	⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	3280	4300	5215	3620	4615	5480
1⅛	3180	4165	5020	3540	4500	5350
1¼	2870	3780	4570	3268	4160	4940
1½	2500	3280	3980	2932	3730	4440
1¾	2166	2840	3445	2600	3040	3930
2	1877	2460	2980	2300	2925	3480
2¼	1630	2140	2590	2040	2590	3085
2⅜	1474	1934	2345	1870	2380	2828
2½	1422	1865	....	1810	2300	2735
2¾	1245	1634	....	1610	2045	2430
3	1096	1440	....	1434	1824	2165
3¼	971	1274	....	1280	1630	....
3½	863	....	....	1150	1464	....
3¾	745	....	....	1036	1320	....
4	693	....	....	937	1194	....
4¼	624	....	....	850	1083	....
4¾	516	....	....	708	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths		1 in. Non-tapered limiting depths	
	⅞ in. only	1 & ⅞ in.	1 in. only	
1	....	....	....	
1⅛	3840	4990	....	
1¼	3605	4450	....	
1½	3290	4050	....	
1¾	2985	3660	....	
2	2690	3320	....	
2¼	2420	3000	....	
2⅜	2240	2765	....	
2½	2180	2690	2475	
2¾	1964	2380	2257	
3	1770	2180	2060	
3¼	1597	1970	1880	
3½	1447	1800	1716	
3¾	1314	1620	1570	
4	1195	1473	1443	
4¼	1090	1340	1324	
4¾	917	1130	1126	

* See appendix

TABLE 2. Carbon manganese steel rods—type 2*—salt water.

Limiting depths of pumps in salt water with various combinations of carbon manganese steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths			¾, ⅞, & 1 in. Comb's. limiting depths		
	⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	3608	4730	5675	3990	5080	6030
1⅛	3500	4580	5525	3895	4950	5885
1¼	3160	4170	5030	3600	4580	5435
1½	2755	3615	4380	3230	4110	4880
1¾	2385	3130	3790	2860	3640	4325
2	2065	2715	3280	2536	3220	3830
2¼	1793	2350	2850	2246	2855	3495
2⅜	1625	2130	2580	2050	2620	3110
2½	1567	2050	....	1990	2535	3010
2¾	1370	1800	....	1770	2250	2670
3	1206	1590	....	1580	2010	2380
3¼	1068	1404	....	1410	1794	....
3½	950	....	....	1267	1610	....
3¾	850	....	....	1141	1454	....
4	762	....	....	1032	1314	....
4¼	687	....	....	937	1192	....
4¾	567	....	....	780	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths		1 in. Non-tapered limiting depths	
	⅞ in. only	1 & ⅞ in.	1 in. only	
1	....	....	....	
1⅛	4225	5490	....	
1¼	3970	4895	....	
1½	3620	4465	....	
1¾	3280	4025	....	
2	2960	3655	....	
2¼	2665	3288	....	
2⅜	2468	3040	....	
2½	2400	2959	2720	
2¾	2160	2620	2482	
3	1950	2400	2268	
3¼	1692	2166	2070	
3½	1591	1980	1890	
3¾	1446	1783	1730	
4	1316	1623	1590	
4¼	1200	1480	1459	
4¾	1009	1244	1240	

* See appendix

TABLE 3. Nickel-molybdenum steel rods—type 3*—salt water.

Limiting depths of pumps in salt water with various combinations of nickel-molybdenum steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	5453	7151	8675	6029	7676	9116
1 1/16	5283	6930	8357	5884	7491	8895
1 1/4	4772	6298	7604	5435	6918	8216
1 1/2	4160	5459	6618	4877	6205	7381
1 3/4	3603	4727	5734	4325	5503	6540
2	3121	4095	4960	3832	4870	5792
2 1/4	2711	3556	4313	3394	4314	5130
2 7/16	2454	3218	3902	3109	3956	4700
2 1/2	2364	3102	....	3010	3830	4549
2 3/4	2071	2718	....	2674	3403	4042
3	1823	2394	....	2384	3034	3600
3 1/4	1614	2118	....	2132	2710	....
3 1/2	1435	....	....	1914	2435	....
3 3/4	1283	....	....	1724	2194	....
4	1152	....	....	1559	1985	....
4 1/4	1038	....	....	1414	1800	....
4 3/4	857	....	....	1177	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1 1/16	6392	8306	....
1 1/4	5998	7395	....
1 1/2	5478	6754	....
1 3/4	4964	6082	....
2	4477	5521	....
2 1/4	4032	4970	....
2 7/16	3733	4601	....
2 1/2	3627	4472	4117
2 3/4	3265	3960	3754
3	2944	3629	3424
3 1/4	2658	3277	3127
3 1/2	2407	2994	2858
3 3/4	2185	2694	2616
4	1989	2452	2400
4 1/4	1815	2237	2204
4 3/4	1525	1880	1874

TABLE 4. High-nickel steel rods—type 4*—salt water.

Limiting depths of pumps in salt water with various combinations of high-nickel steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	6175	8100	9825	6830	8700	10340
1 1/16	5990	7850	9470	6670	8480	10090
1 1/4	5410	7140	8615	6160	7870	9310
1 1/2	4710	6190	7500	5525	7025	8365
1 3/4	4080	5360	6490	4900	6240	7415
2	3535	4640	5620	4340	5520	6570
2 1/4	3070	4027	5000	3845	4890	5820
2 7/16	2780	3648	4420	3522	4480	5325
2 1/2	2680	3510	....	3410	4340	5150
2 3/4	2345	3080	....	3030	3855	4580
3	2065	2715	....	2700	3440	4080
3 1/4	1830	2400	....	2412	3070	....
3 1/2	1626	....	....	2170	2760	....
3 3/4	1454	....	....	1954	2490	....
4	1305	....	....	1767	2240	....
4 1/4	1176	....	....	1603	2040	....
4 3/4	971	....	....	1335	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1 1/16	7240	9400	....
1 1/4	6900	8380	....
1 1/2	6210	7650	....
1 3/4	5615	6890	....
2	5075	6260	....
2 1/4	4570	5630	....
2 7/16	4225	5215	....
2 1/2	4140	5070	4660
2 3/4	3700	4485	4250
3	3340	4115	3880
3 1/4	3010	3750	3540
3 1/2	2800	3481	3240
3 3/4	2475	3055	2960
4	2265	2780	2720
4 1/4	2060	2535	2500
4 3/4	1730	2130	2124

* See appendix

TABLE 5. Nickel-chromium steel rods—type 5—salt water.

Limiting depths of pumps in salt water with various combinations of nickel-chromium steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	3460	4535	5500	3825	4870	5780
1 1/16	3355	4400	5300	3735	4750	5650
1 1/4	3030	4000	4755	3450	4385	5215
1 1/2	2640	3460	4200	3095	3935	4680
1 3/4	2284	3000	3635	2745	3490	4150
2	1980	2600	3148	2430	3090	3675
2 1/4	1700	2256	2735	2152	2735	3255
2 7/16	1558	2040	2475	1974	2510	2980
2 1/2	1500	1966	....	1910	2430	2885
2 3/4	1315	1724	....	1694	2177	2565
3	1157	1467	....	1515	1925	2280
3 1/4	1024	1344	....	1350	1720	....
3 1/2	911	....	....	1215	1545	....
3 3/4	815	....	....	1095	1394	....
4	731	....	....	990	1260	....
4 1/4	660	....	....	898	1147	....
4 3/4	544	....	....	747	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1 1/16	4050	5265	....
1 1/4	3809	4695	....
1 1/2	3476	4285	....
1 3/4	3145	3860	....
2	2840	3500	....
2 1/4	2506	3150	....
2 7/16	2368	2920	....
2 1/2	2300	2838	2610
2 3/4	2072	2612	2380
3	1868	2300	2175
3 1/4	1686	2080	1985
3 1/2	1527	1900	1814
3 3/4	1387	1710	1660
4	1262	1560	1523
4 1/4	1152	1420	1397
4 3/4	968	1194	1190

TABLE 6. Carbon steel rods—type 1*—H_2S.

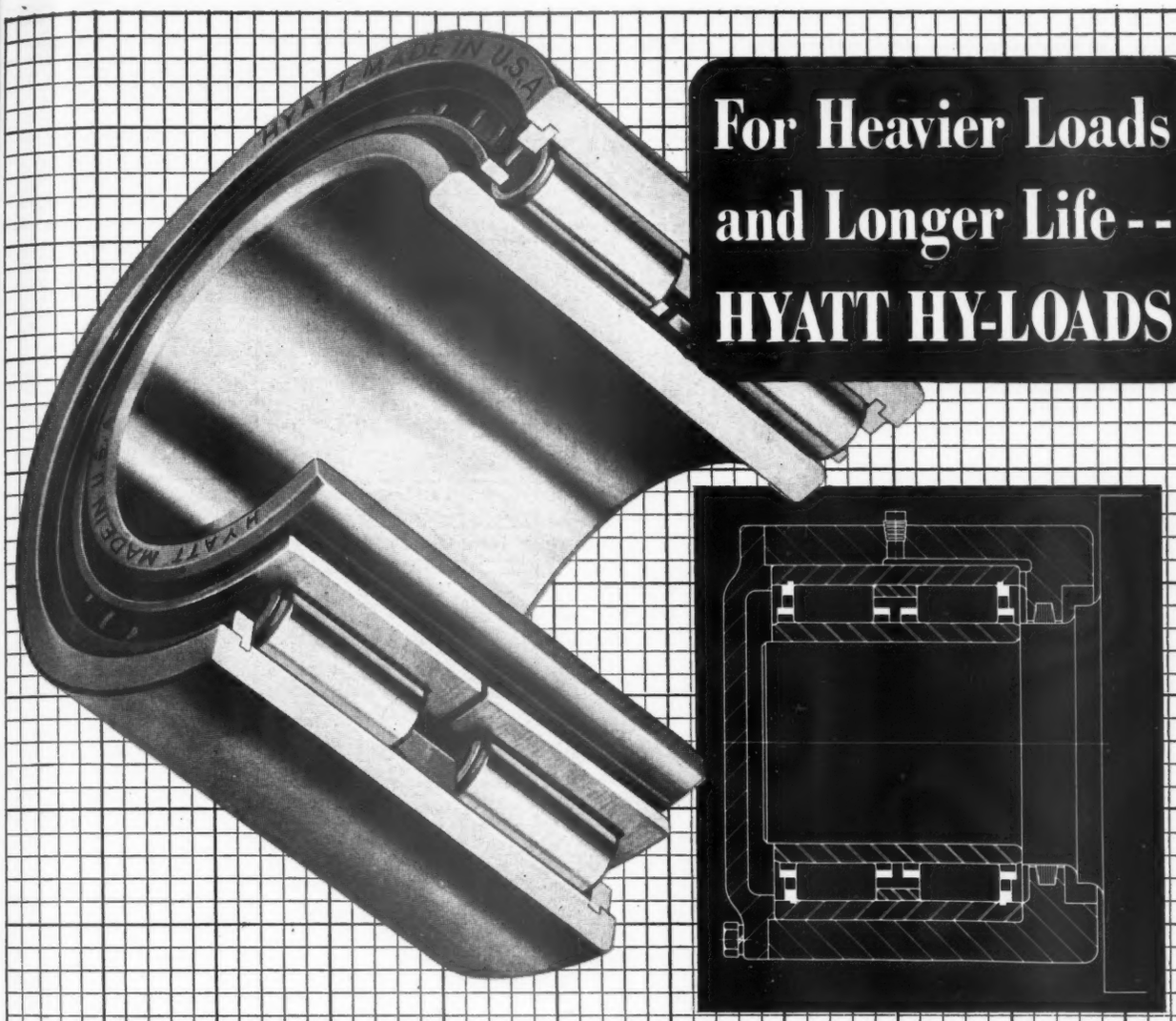
Limiting depths of pumps in H_2S with various combinations of carbon steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	1800	2354	2859	1986	2530	3004
1 1/4	1572	2077	2508	1790	2280	2709
1 1/2	1370	1800	2180	1606	2045	2430
1 3/4	1187	1558	1890	1425	1812	1910
2	1030	1350	1635	1265	1605	1690
2 1/4	892	1173	1427	1120	1422	1548
2 7/16	809	1061	1287	1025	1304	1497
2 1/2	780	1023	....	991	1263	1330
2 3/4	683	896	....	882	1122	1187
3	600	790	....	788	998	....
3 1/4	532	698	....	702	892	....
3 3/4	423	....	....	568	722	....
4	380	....	....	514	654	....
4 1/4	342	....	....	466	593	....
4 3/4	282	....	....	388	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1 1/4	1977	2440	....
1 1/2	1805	2228	....
1 3/4	1638	2006	....
2	1475	1820	....
2 1/4	1328	1637	....
2 7/16	1230	1516	....
2 1/2	1195	1473	1357
2 3/4	1076	1306	1236
3	969	1197	1127
3 1/4	877	1078	1030
3 3/4	721	888	862
4	655	809	791
4 1/4	598	736	727
4 3/4	503	620	618

* See appendix

For Heavier Loads and Longer Life -- HYATT HY-LOADS



The cut-away Hyatt Hy-Load Roller Bearing illustrated is the A-TS Duplex Type, 6200 Series. Duplex type Hy-Load bearings are much wider and have much greater load capacity than other standard series bearings of the same bore size. Two roller-separator sets are assembled with the outer race as a unit. The roller sets are spaced by a steel ring centered in the bore of the outer race.

While Duplex Bearings can sustain extremely heavy loads, the allowable deflection of the shaft is usually a limiting factor. The extra capacity is therefore utilized, in most cases, to meet a greater life requirement.

The straight, separable inner race type of construction makes possible simple methods of assembling machine parts and most efficient lubrication sealing. It also allows axial expansion or slight oscillation without cramping the roller ends.

The separable parts are freely interchangeable as any inner race will fit any roller assembly of the same number. The inner race can be omitted and the rollers operated directly upon a hardened and ground shaft.

The drawing shown above is a conventional bearing arrangement for a long shaft or roll and illustrates the application of a 6200 series bearing. All Hyatt Hy-Load Bearings are shown in our new Hy-Load Bearing Catalog, number 547. Write for your copy today. Hyatt Bearings Division, General Motors Corporation, Harrison N. J.

HYATT ROLLER BEARINGS

TABLE 7. Carbon-manganese steel rods—type 2*—H_2S.

Limiting depths of pumps in H_2S with various combinations of carbon manganese steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	2658	3477	4220	2932	3734	4435
1¼	2320	3066	3700	2643	3366	4000
1½	2024	2658	3220	2371	3020	3589
1¾	1753	2300	2790	2103	2677	3180
2	1520	1992	2415	1867	2370	2820
2¼	1318	1730	2108	1656	2100	2498
2⅜	1195	1566	1900	1514	1925	2287
2½	1152	1510	....	1464	1864	2210
2¾	1009	1324	....	1303	1656	1964
3	887	1166	....	1163	1475	1754
3¼	786	1030	....	1037	1317	....
3¾	624	....	....	839	1067	....
4	561	....	....	758	966	....
4¼	505	....	....	688	876	....
4¾	417	....	....	572	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1¼	2920	3600	....
1½	2665	3290	....
1¾	2418	2961	....
2	2178	2687	....
2¼	1960	2418	....
2⅜	1817	2240	....
2½	1764	2174	2004
2¾	1588	1928	1825
3	1431	1767	1663
3¼	1295	1592	1520
3¾	1064	1310	1274
4	968	1195	1168
4¼	882	1087	1074
4¾	814	916	912

TABLE 8. Nickel-molybdenum steel rods—type 3*—H_2S.

Limiting depths of pumps in H_2S with various combinations of nickel-molybdenum steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	3715	4860	5900	4100	5220	6200
1¼	3245	4285	5175	3695	4705	5590
1½	2830	3715	4500	3315	4220	5015
1¾	2450	3215	3900	2940	3740	4445
2	2125	2785	3375	2610	3310	3940
2¼	1842	2420	2945	2310	2935	3490
2⅜	1670	2190	2655	2115	2690	3195
2½	1610	2110	....	2045	2605	3090
2¾	1410	1850	....	1820	2315	2745
3	1240	1630	....	1625	2060	2450
3¼	1098	1440	....	1450	1840	....
3¾	873	....	....	1173	1490	....
4	784	....	....	1060	1350	....
4¼	706	....	....	962	1224	....
4¾	583	....	....	800	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1¼	4080	5035	....
1½	3725	4600	....
1¾	3380	4140	....
2	3042	3755	....
2¼	2740	3380	....
2⅜	2540	3130	....
2½	2465	3040	2800
2¾	2220	2695	2550
3	2000	2470	2325
3¼	1810	2225	2125
3¾	1487	1832	1780
4	1352	1670	1632
4¼	1234	1520	1500
4¾	1038	1280	1275

* See appendix

TABLE 9. High-nickel steel rods—type 4*—H_2S.

Limiting depths of pumps in H_2S with various combinations of high-nickel steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	4048	5295	6430	4465	5685	6754
1¼	3536	4669	5640	4024	5125	6087
1½	3082	4049	4900	3610	4587	5460
1¾	2670	3502	4250	3202	4073	4841
2	2315	3034	3676	2843	3607	4290
2¼	2007	2637	3208	2517	3197	3802
2⅜	1820	2386	2892	2304	2930	3480
2½	1754	2299	....	2227	2839	3368
2¾	1536	2016	....	1983	2521	2990
3	1350	1775	....	1770	2244	2670
3¼	1196	1569	....	1580	2005	....
3¾	951	....	....	1276	1624	....
4	854	....	....	1155	1470	....
4¼	769	....	....	1048	1333	....
4¾	635	....	....	872	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1¼	4445	5485	....
1½	4058	5007	....
1¾	3680	4510	....
2	3314	4090	....
2¼	2986	3683	....
2⅜	2768	3410	....
2½	2686	3310	3050
2¾	2419	2937	2778
3	2180	2690	2533
3¼	1972	2424	2315
3¾	1620	1996	1940
4	1473	1820	1778
4¼	1344	1655	1635
4¾	1130	1395	1390

TABLE 10. Nickel-chromium steel rods—type 5*—H_2S.

Limiting depths of pumps in H_2S with various combinations of nickel-chromium steel sucker rods and assuming maximum load = 1.363 × static load, or 20—64 in. SPM

Plunger size, in.	⅝, ¾, & ⅞ in. Comb's. limiting depths: ⅝ in. only	¾ & ⅝ in.	⅞, ¾ & ⅝ in.	¾, ⅞, & 1 in. Comb's. limiting depths: ¾ in. only	⅞ & ¾ in.	1 in., ⅞ & ¾ in.
1	2808	3670	4458	3098	3942	4682
1¼	2451	3238	3910	2790	3555	4221
1½	2139	2807	3400	2505	3188	3790
1¾	1850	2430	2947	2220	2826	3360
2	1605	2105	2550	1971	2500	2978
2¼	1392	1828	2225	1745	2218	2638
2⅜	1262	1655	2008	1598	2033	2414
2½	1216	1595	....	1545	1969	2335
2¾	1065	1398	....	1375	1750	2074
3	936	1231	....	1228	1556	1850
3¼	830	1088	....	1096	1390	....
3¾	660	....	....	886	1126	....
4	592	....	....	800	1020	....
4¼	534	....	....	727	924	....
4¾	441	....	....	604	....	....

Plunger size, in.	⅞ & 1 in. Comb's. limiting depths: ⅞ in. only	1 & ⅞ in.	1 in. Non-tapered limiting depths: 1 in. only
1	....	....	....
1¼	3081	3803	....
1½	2814	3473	....
1¾	2554	3128	....
2	2300	2838	....
2¼	2070	2554	....
2⅜	1920	2365	....
2½	1862	2297	2115
2¾	1677	2037	1926
3	1511	1865	1757
3¼	1368	1681	1605
3¾	1124	1385	1345
4	1022	1262	1234
4¼	932	1148	1134
4¾	784	967	963

* See appendix

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TABLE 11. Per cent of each size rod in tapered rod strings.

Plunger size, in.	Rod combinations					
	1 in.	⅞ in.	¾ in.	⅞ in.	¾ in.	⅝ in.
¾	....	....	....	18.42	20.66	60.92
15/16	....	....	....	20.05	22.48	57.47
1	17.22	19.68	63.19	20.67	23.18	56.15
1 1/16	17.64	20.17	62.19	21.33	23.94	54.73
1 1/4	19.07	21.80	59.13	23.56	26.43	50.01
1 1/2	21.33	24.39	54.28	27.10	30.39	42.51
1 3/4	24.01	27.44	48.55	31.28	35.08	33.64
2	27.09	30.97	41.94	36.10	40.48	23.42
2 1/4	30.59	34.97	34.44	41.56	46.61	11.83
2 7/16	33.39	38.17	28.44	46.08	51.68	2.24
2 1/2	34.50	39.48	26.02	....	....	....
2 3/4	38.82	44.38	16.80	....	....	....
3	43.55	49.79	6.66	....	....	....
3 1/4	....	....	....	....	....	....
3 1/2	....	....	....	....	....	....
3 3/4	....	....	....	....	....	....
4	....	....	....	....	....	....
4 1/4	....	....	....	....	....	....

Plunger size, in.	Rod combinations					
	1 in.	⅞ in.	⅞ in.	¾ in.	¾ in.	⅝ in.
¾	....	....	21.37	78.63	25.05	74.95
15/16	....	....	22.78	77.22	27.27	72.73
1	19.51	80.49	23.32	76.68	28.11	71.89
1 1/16	19.90	80.10	23.90	76.10	29.01	70.99
1 1/4	21.18	78.82	25.84	74.16	32.05	67.95
1 1/2	23.22	76.78	28.91	71.09	36.85	63.15
1 3/4	25.63	74.37	32.54	67.46	42.53	57.47
2	28.41	71.59	36.73	63.27	49.09	50.91
2 1/4	31.56	68.44	41.48	58.52	56.52	43.48
2 7/16	34.17	65.83	45.40	54.60	62.67	37.33
2 1/2	35.08	64.92	46.79	53.21	64.83	35.17
2 3/4	38.98	61.02	52.65	47.35	74.00	26.00
3	43.24	56.76	59.07	40.93	84.06	15.94
3 1/4	47.87	52.13	66.05	33.95	94.98	5.02
3 1/2	50.88	49.12	73.59	26.41	....	....
3 3/4	58.25	41.75	81.69	18.31	....	....
4	64.00	36.00	90.35	9.65	....	....
4 1/4	70.15	29.85	99.553	0.447	....	....
4 3/4	83.33	16.67	....	....	....	....

APPENDIX
Example Data Sheets

Data Sheet 1

THEORETICAL DATA SHEET
FOR
NEW SUCKER ROD PUMPING INSTALLATIONS

RESERVOIR DATA

Lease & Well Number_____

Field_____ County_____ State_____

Producing Formation_____ Depth____ ft. to____ ft.

Type of Formation_____

Type of Drive_____

Expected Life of Well_____

PRODUCTION DATA

Total Depth_____ ft. PBD_____ ft. Theor. Pump Depth_____ ft.

Casing: Size Prod. String_____ in. Type_____ Set At_____ ft.

Feet of Open Hole_____ ft. Perforated_____ ft. to_____ ft.

Tubing: Size_____ in. Type_____ Set At_____ ft.

Fluid Level Data: Static Fluid Level_____ ft. Pumping_____ ft.

Pressure Data: Tubing_____ psi, Casing_____ psi

Bottom Hole Pressure_____ psi at_____ ft. Est.____ Meas.____

Total Present Production_____ BPD, Oil_____ BPD, _____ % Water

G.O.R._____

A.P.I. Gravity of oil_____ ° API Is oil sour?____ Is gas sour?_____

Total Maximum Future Production_____ BPD, Oil_____ BPD

_____ % Water _____ G.O.R.

Maximum Expected Pumping Depth_____ ft.

PRODUCTION TROUBLES LIKELY TO BE ENCOUNTERED

Sand_____ Paraffin_____ Corrosion_____ Metallic Scales_____

Gyp or Chemical Scales and Depositions_____

Caving Hole_____ Crooked Hole_____

Excessive Gas_____ Other_____

Remarks

Data Sheet 2

THEORETICAL CALCULATIONS FOR SUCKER ROD INSTALLATIONS

LEASE & WELL NO._____ FIELD_____

COUNTY_____ STATE_____

TRIAL CALCULATION NUMBER	1	2	3	4	5
1. Cycle: Pumping Speed (SPM)					
1. Cycle: Polished Rod Stroke Length (in.)					
2. Selected Plunger Size (in.)					
3. Tubing Size (in.)					
4. Pump Depth (ft)					
5. Est. Fluid Level or ft Lift (ft)					
6. Rod Combination					

Feet & Per Cent of Each Size Rod

Size Rod, in.	1 ft	1 %	2 ft	2 %	3 ft	3 %	4 ft	4 %	5 ft	5 %	wt, lb	wt, lb	wt, lb	wt, lb	wt, lb
1															
⅞															
¾															
⅝															
Totals															

7. Equivalent Specific Gravity of Fluid						
8. Fluid Weight	Rod Size	Fluid wt/Rod Section in Pounds				
	1					
	⅞					
	¾					
	⅝					
Total Fluid Weight (lb)						
9. Acceleration Factor (Mills)						
10. Accelerated Rod Load (lb)						
11. Total Accelerated Upstroke Load (lb)						
12. Total Rod Stretch (in.)						
13. Total Tubing Stretch (in.)						
14. Total Uncorrected Rod & Tubing Stretch (in.)						
15. Total Corrected Rod & Tubing Stretch (in.)						
16. Overtravel Factor (Coberly)						
17. Accelerated Plunger Stroke (in.)						
18. Net Plunger Stroke (in.)						
19. Production Based on Net Plunger Stroke (BPD)						
20. Production Based on Avg. V.E. of Pump (BPD)						
21. Est. Peak Torque (in.-lb)						
22. Est. Counterbalance (lb)						
23. Est. Hydraulic Horsepower (hp)						
24. Est Required Brake Horsepower (bhp)						
25. Est. Electric Motor Horsepower Rating (hp)						
26. Prime Mover Sheave Size, Type & No. Grooves						
27. Unit Sheave Size, Type & No. of Grooves						

Sucker Rod Types

1. The following sucker rods may be used for light to medium loads in areas where non-corrosive conditions exist. An example of this is the East Texas Area.

Carbon-steel rods.

Size, in.	Approximate endurance limits, lb
⅝	6,110
¾	8,800
⅞	11,950
1	15,620

2. The following sucker rods may be used for light and medium loads in areas where mildly corrosive conditions exist. An example of this would be the Wasson Field, the Johnson Field, and the North Cowden Field in West Texas.

Carbon-manganese steel rods.

Size, in.	Approximate endurance limits, lb	
	Salt water	H_2S
5/8	6,730	4,950
3/4	9,700	7,120
7/8	13,170	9,680
1	17,200	12,630

3. The following sucker rods may be used for light to heavy loads in areas where hydrogen sulfide corrosion is encountered. Examples of this are found in Oklahoma, Kansas, and Arkansas areas.

Nickel-molybdenum steel rods.

Size, in.	Approximate endurance limits, lb	
	Salt water	H_2S
5/8	10,170	6,910
3/4	14,620	9,950
7/8	19,900	13,520
1	26,000	17,660

4. The following sucker rods may be used in areas where severe hydrogen-sulfide corrosion is encountered. Examples of this are problem wells in Oklahoma, Kansas, and Arkansas.

High-nickel steel rods.

Size, in.	Approximate endurance limits, lb
	H_2S
5/8	7,260
3/4	10,310
7/8	14,050
1	18,270

5. The following sucker rods may be used in areas where corrosive oil well brines not containing hydrogen-sulfide are encountered. An example of this is the Texas Gulf Coast area.

Nickel-chromium steel rods.

Size, in.	Approximate endurance limits, lb
	Salt water
5/8	10,600
3/4	16,450
7/8	22,450
1	29,150

Basic Formulas

The tables and nomographs of this report are based on the formulas that follow:

1. **Limiting depth** (Tables 1-10)

$$D = EA/(W_f + W_r)\,\alpha$$

D = Limiting depth, ft
A = Area, sq in.
E = Endurance limit, psi
W_f = Wt fluid, lb/ft
W_r = Wt rods, lb/ft
α = Acceleration factor

2. **Synchronous orders** (Fig. 4)

$$F = 237000/N\ (D)$$

F = Frequency of vibrations, SPM
N = Number of order
D = Pump depth, ft

3. **Mills acceleration factor** (Fig. 5)

$$\alpha = 1 + \frac{LN^2}{70500}$$

α = Mills acceleration factor
L = Length of stroke, in.
N = Pumping speed, SPM

4. **Specific gravity for oil and water mixtures** (Fig. 7)

S.G. = % H_2O (S.G. H_2O) + % Oil (S.G. Oil)
S.G. = Specific Gravity

5. **Fluid weight** (Fig. 8)

$$W_f = 0.434\ \text{S.G.}\ (A_p - A_r)\ L$$

W_f = Weight of fluid, lb
S.G. = Specific gravity of fluid
A_p = Plunger area, sq in.
A_r = Rod area, sq in.
L = Depth of fluid, ft

6. **Rod or tubing stretch** (Figs. 9, 10, and 11)

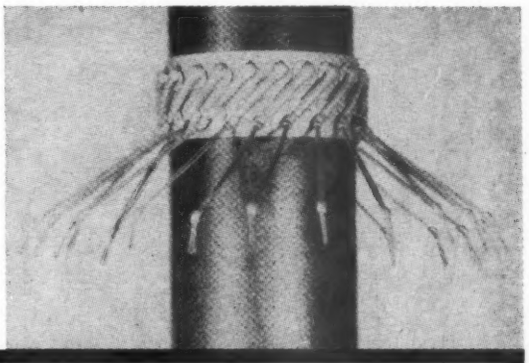
$$e = \frac{144\ W_f\ A_p\ L_1\ L_2}{E\ A_r}$$

e = Elongation, in.
W_f = Wt fluid, lb/cu in.
A_p = Area plunger, sq in.
A_r = Area rod, sq in.
L_1 = Fluid depth, ft
E = Modulus of elasticity, psi
L_2 = Length of rod string

7. **Over-travel factor** (Fig. 13)

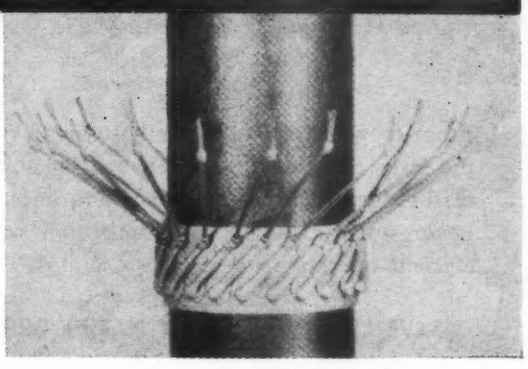
$$OF = 1 + \frac{.0193(LN)^2}{1000}$$

B and W Multi-Flex Scratchers are obviously not run in this upside down position. They would definitely scratch off the mud cake as casing is run.



Use B and W
MULTI-FLEX SCRATCHERS
and
... "Don't tear up the hole"

The upturned multiple wires protect the mud cake as the casing is run to bottom. Mud cake removal is done only after casing reaches bottom and as the casing is raised and the cement slurry pumped into position. The hazard of circulating off bottom is eliminated.



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OF = Over-travel factor
L = Length of rod, thousands of ft
N = Number of strokes per minute

8. **Peak torque** (Fig. 14)

$PT = 0.4\,[W_f + (W_r)\,\alpha\,]\,L/2$

PT = Peak torque, in. lb
W_f = Wt fluid, lb
W_r = Wt rods, lb
α = Mills acceleration factor
L = Length of stroke, in.

9. **Hydraulic horsepower** (Fig. 15)

$$HHP = \frac{P \times W_h \times FL}{33000 \times 24 \times 60}$$

HHP = Hydraulic horsepower
P = Production, BPD
W_b = Wt per bbl, lb/bbl
FL = Feet lift, ft

10. **Sheave size** (Fig. 16)

$$S_u = \frac{S_e \times S_p}{S \times RG}$$

S_u = Unit sheave size, in.
S_e = Engine sheave size, in.
S_p = Engine speed, rpm
S = Pumping speed, spm
RG = Gear ratio

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PART 2—Conclusion

Milfay pool is situated in Township 15 North, Range 17 East, Creek County, Oklahoma. The Wilcox Sandstone, found at a depth of 3900 ft on an anticlinal structure, has a maximum thickness of 94 ft above a water-oil contact. The pool is gas-drive.

The discovery well, marked No. 1 in Fig. 14, was drilled in December 1941. The dashed line shows the ultimate area of development and the hachured line shows the area of initial development, marked Area "A". The discovery well was near the northwestern productive limit of the pool and was completed for an initial production of 130 bbl per day. Well No. 2 was drilled as a diagonal 40-acre offset and had initial production of 100 bbl per day. A 2-year lapse in drilling occurred, but by July, 1946, a total of 6 wells had been completed on 40-acre spacing within the original development Area "A". The production history on Area "A" is shown in Fig. 15 up to the end of the year 1946.

In December 1946 the pool was extended by the drilling of a well marked No. 7 on Fig. 16 and there followed the development of the entire pool with 43 wells on 10-acre spacing. The wells were drilled in the order numbered in Fig. 16.

The map in Fig. 17 represents contours on the top of the Wilcox Sandstone. Fig. 18 is a cross-section to show the original oil-water contact and to point out that the Area "A" first developed was in the thinner section where the saturated thickness represented only 22 per cent of the productive sand volume.

In Fig. 19 the production history of Area "A" is continued to show the result of in-fill drilling 7 additional wells to bring the well density to 10-acres per well. The 13 wells in Area "A" had an accumulated production of 569,000 bbl at the end of 1949. The decline curve on the original 6 wells indicated the same volume of total production within a year to a year and a half longer time, at which time

†Presented at the Spring Meeting of the Mid-Continent District API Division of Production, Skirvin Hotel, Oklahoma City, Oklahoma, March 29-31, 1950.

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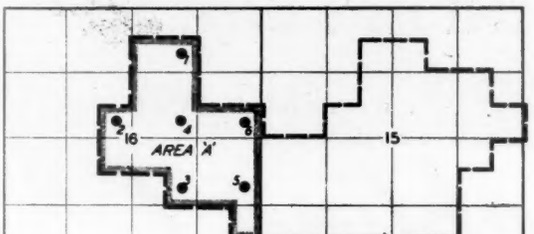

FIG. 14

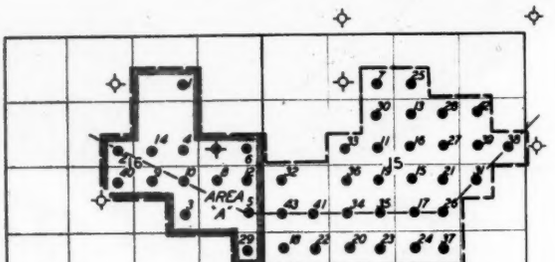

FIG. 16

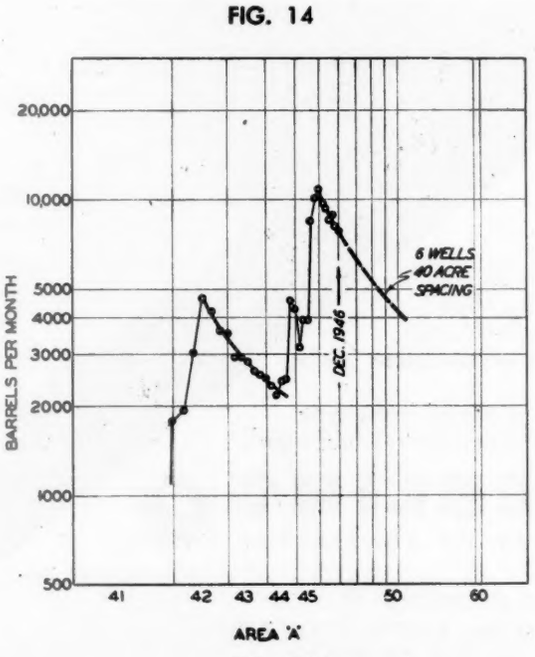

FIG. 15

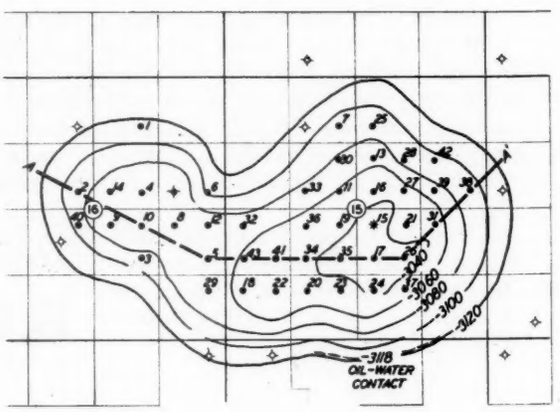

FIG. 17

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More than ten years before the playing of the first World Series, Jones introduced the first all-metal sucker rod. In 1903, millions of feet were already in service.

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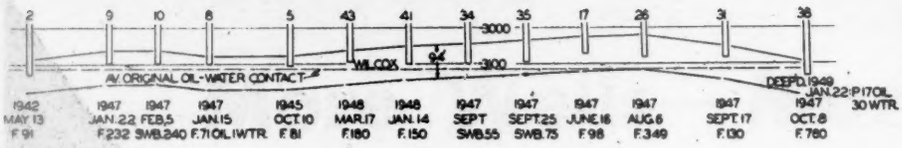


FIG. 18

the original 6 wells would have been producing 4000 bbl per month as compared to the present production of 2000 bbl per month from 13 wells. More wells did not mean more oil. The production history of the 6 wells shows that they were draining an area of the pool substantially larger than Area "A".

Well Interference

The ability of wells to drain from a large part of the common source of supply is readily illustrated by the production curves of the first two wells drilled in the Milfay Pool, Fig. 20 and 21. The production from the wells, during the 2½ years or so they were the only wells in the pool, gradually changed from a declining rate to one that was more or less sustained because of the drainage to these wells from the expansion of the oil in gas in the large untapped portion of the pool. They lost a part of that large oil drainage to Wells 3, 4, 5, and 6 when they were drilled in Area "A" to complete the 40-acre spacing pattern. This loss is shown in the accelerated rate of decline in the production curves from mid-year 1945 to the end of 1946. In the period following 1946 when the entire pool was developed on 10-acre spacing, these two wells lost further drainage and showed a still greater rate of decline and are almost at an economic limit of production.

West Agra

This pool is located in Township 17 North, Range 3 and 4 East, Lincoln County, Oklahoma, at a depth of 5100 ft, and has a maximum productive thickness of 8 ft of Cleveland Sandstone. The structure is a monocline dipping 60 ft from the discovery well to the Southwest edge well. The productive limits of the pool are estab-

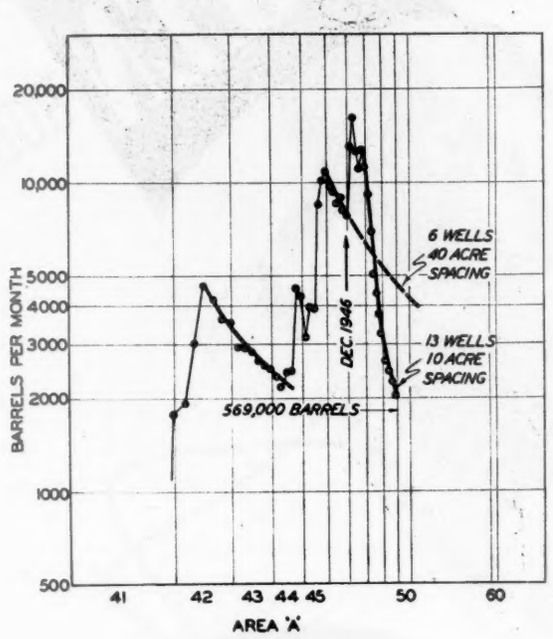


FIG. 19

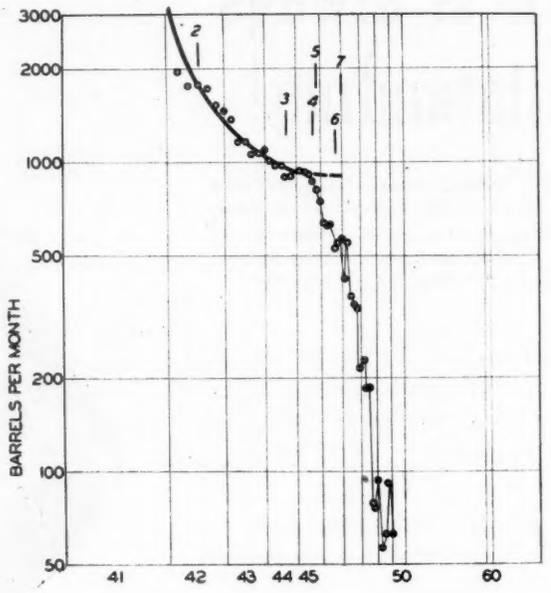


FIG. 20

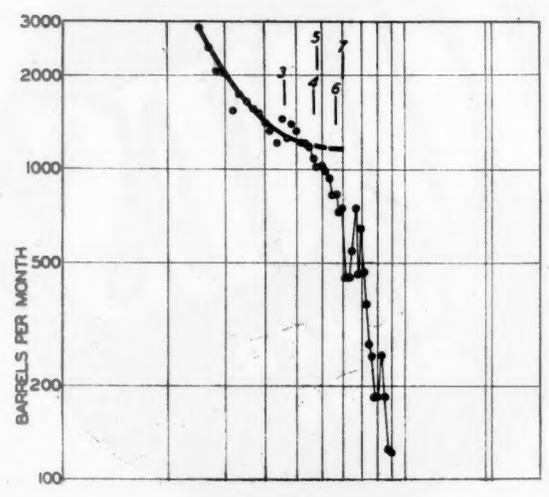


FIG. 21

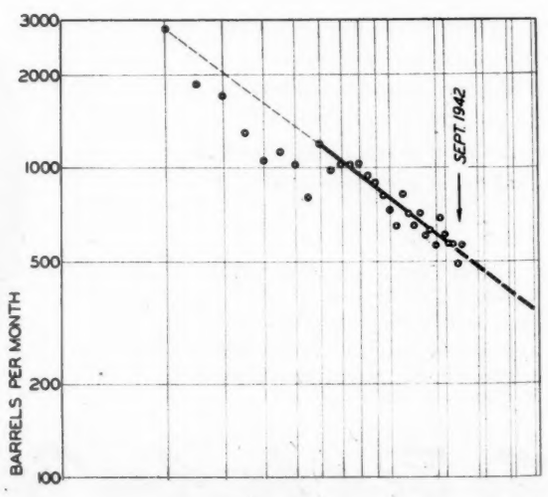
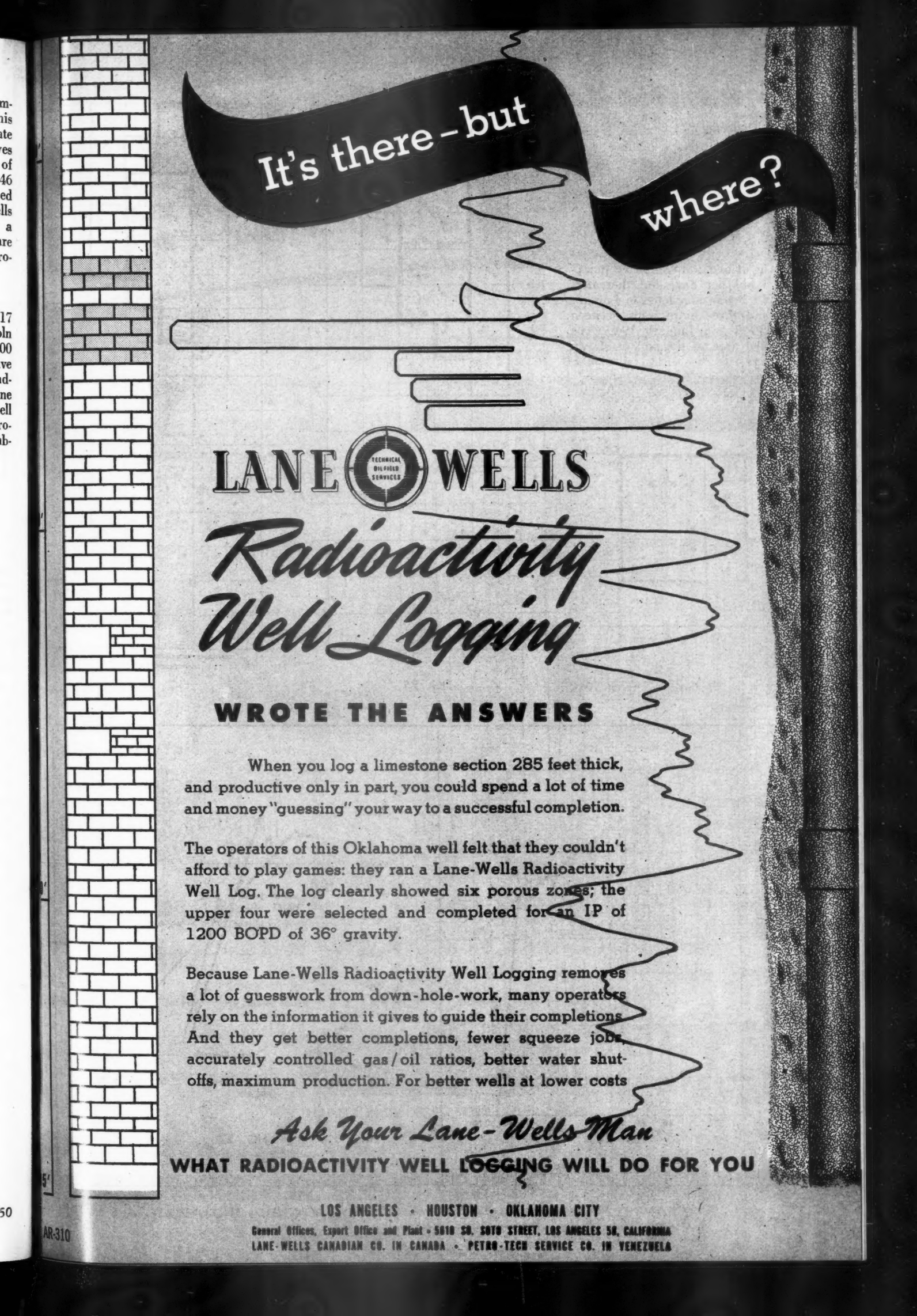


FIG. 22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lished by the absence of permeability.

The discovery well was completed in June 1927 for an initial production of 125 bbl per day. No other wells were drilled in the pool for a period of 15 years by which time the discovery well had declined to a production of 17 bbl per day. The production history of the discovery well is shown on Fig. 22.

In December 1942 a 10-acre offset well was drilled and completed pumping 60 bbl per day, and thereafter Well No. 3 was completed in January 1944 and three more wells between April 1948 and January 1949. The developed area of the pool is shown

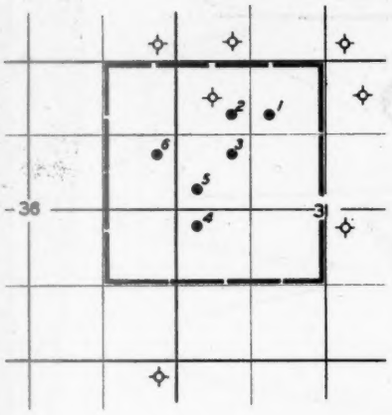

FIG. 23

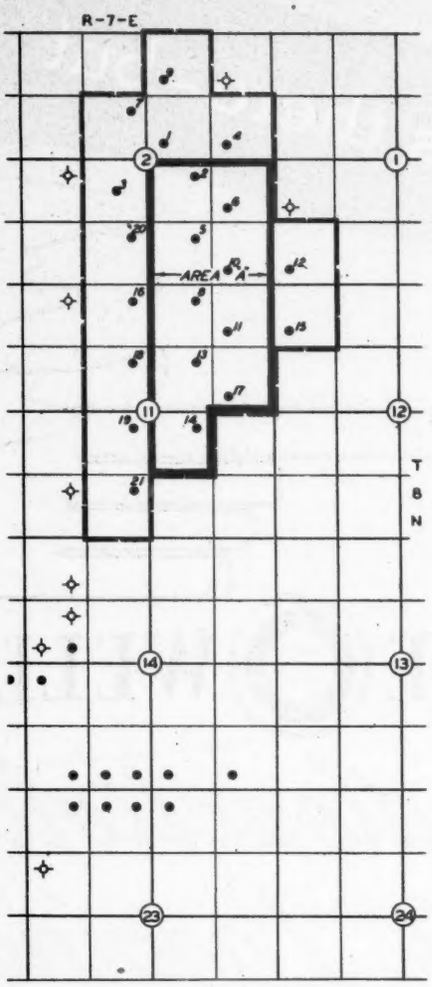

FIG. 25

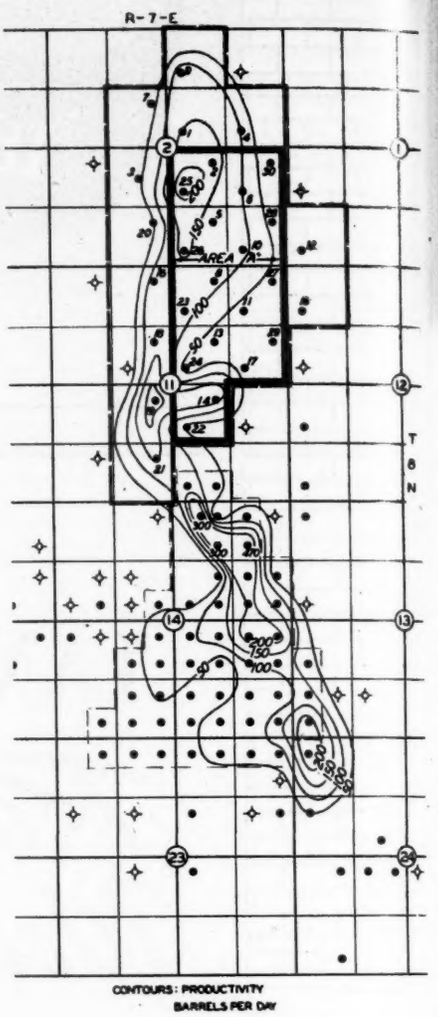

FIG. 26

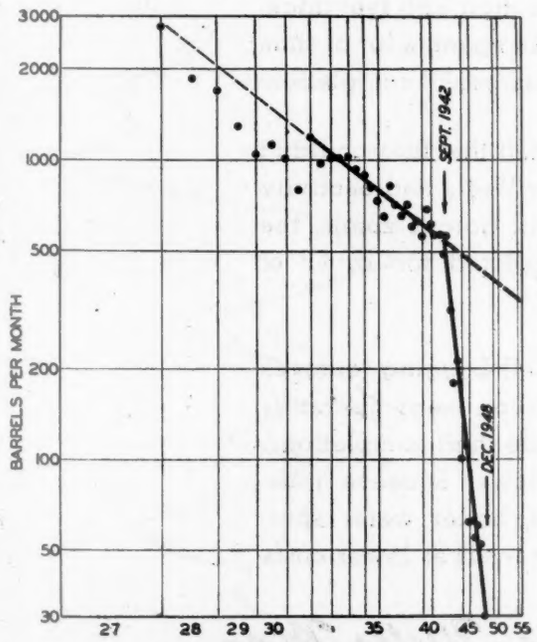

FIG. 24

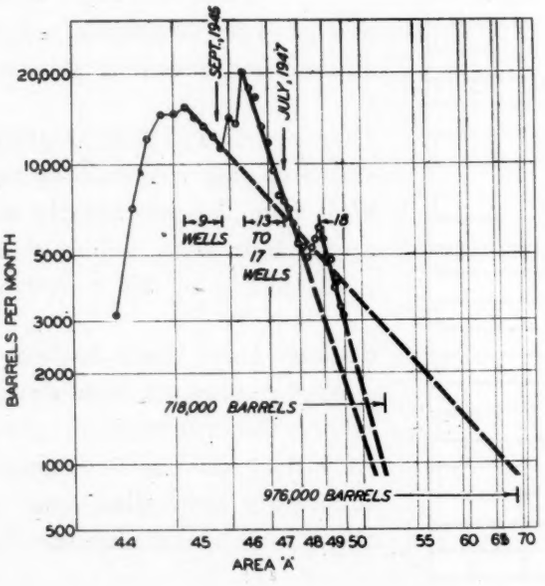

FIG. 27

O'HARA LIMESTONE
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18

Mud (Aquagel): R_m 2.0 at BHT
Bit Size: 8¾"
Spacings: AM = 16"
AM' = 55"

LOG ANALYSIS

1) Water saturation S

R_w = 0.065 ohm — samples from adjacent wells
F = 35 — laboratory analysis from cores in adjacent wells
$R_o = FR_w = (35)\ (0.065) = 2.3$ ohms
R_t = 125 ohms

$$S = \sqrt{\frac{2.3}{125}} = 13.6\%$$

2) Porosity p

$$p = \sqrt[m]{\frac{1}{F}} = 17\% \text{ for } m = 2$$

"MICROLOG" — indicates good permeability from 2516' to 2535'

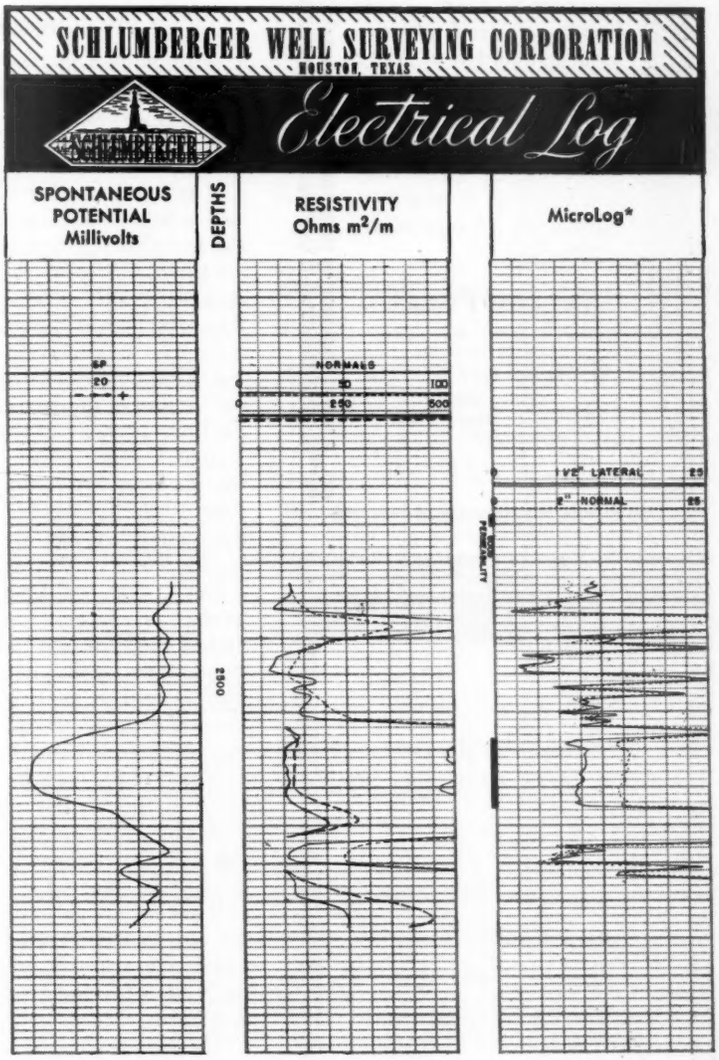
CORE ANALYSIS

Average Porosity	17.4%
Average Water Saturation	20%

PRODUCTION RESULTS

Perforated: 2512' - 2535'
Potential: 2955 bbl/day after acidizing

*"MicroLog" is a trade mark of the Schlumberger Well Surveying Corp.



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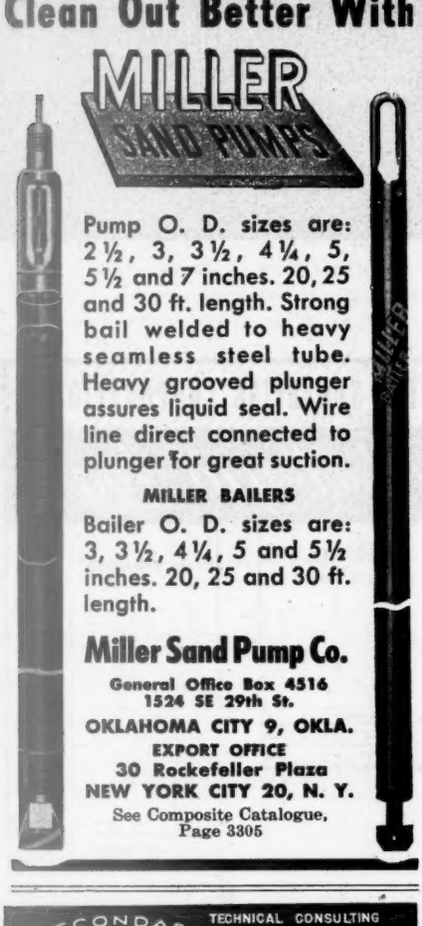

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in Fig. 23 with the wells numbered in order of drilling.

In Fig. 24 the production history of Well No. 1 subsequent to September 1942 demonstrates the effect of additional development on the production from the discovery well. Interference was established by the drilling of Well No. 2 in December 1942 before Well No. 3 was completed in September 1943 at which time the production from the discovery well had already dropped to 200 bbl per month. Well No. 1 was plugged and abandoned in 1949.

Wewoka Lake

This pool is located in Township 8 North, Range 7 East, Seminole County, Oklahoma, at a depth of 3200 ft with an average thickness of Booch Sand of 26 ft.

The analysis of the history of drilling in this pool must take into account the fact that the South edge of a larger common source of supply was drilled and produced for a long period before the presence of the larger productive area was established. On the map in Fig. 25 there are indicated twelve wells on or about the section line between Sections 14 and 13, Township 8 North, Range 7 East, which wells comprise the Jackson Pool, first drilled in the year 1926. To the North lies an area discovered by the drilling of a well in the SW SW NE, Sec. 2, Township 8 North, Range 7 East, which was regarded a discovery well of a pool named the Wewoka Lake Booch Sandstone. This well, marked No. 1, in Fig. 25, wsa drilled and completed in December 1943 for an initial production of 150 bbl per day. Subsequent drilling led to juncture of the Wewoka Lake Pool with the old Jackson Pool with the situation ultimately developing into that reflected by Fig. 26. On this latter figure are contours of initial well potentials reflecting the fact that the old Jackson Pool was a part of a much larger source of supply and that the wells of highest potential were in that area.

The pool is located on a 2-mile long north-plunging nose and has about 50 ft of structural relief for which reason the structural feature is of little significance in establishing production histories.

The initial potential of wells in the old Jackson area to the South ranged from 5 to 256 bbl per day and averaged about 75 bbl per day. The twelve wells first drilled in the old Jackson Pool had accumulated production of 667,000 bbl to January 1 1950 and the 6 wells which remain unplugged produce 16 bbl per day.

In the Wewoka Lake Area of the pool development was on a 40-acre basis through the year 1945. After war-time drilling restrictions were removed, 9 wells were in-fill drilled on 20-acres in Area "A". In 1946 drilling extended southward and the Wewoka Lake Area was joined with the Jackson Pool, which by this time was developed on a 10-acre pattern.

The production history of Area "A" covering the initial development of 9 wells on 40-acres, the in-fill drilling on 20-acres to bring the total wells to 18, is represented in Fig. 27. If the decline curve of the original 9 wells on 40-acres were extrapolated to 900 bbl per month the indicated ultimate recovery would be 976,000 bbl. The indicated ultimate recovery to the same point of production for 18 wells in Area "A" is 718,000 bbl. Here again, more wells did not mean more oil production from an area of the pool. This without much question was primarily due to the fact that the development outside of Area "A" was in a higher potential, more densely drilled area in the same common source of supply, which resulted in drainage away from Area "A" in spite of the additional drilling. Were one to make an effort to state that the recovery was higher in the Jackson area simply due to the closer spacing, without recognizing the drainage from Area "A", an error in conclusion in respect to the effect of spacing on ultimate recovery from the pool would result.

Significance of Interference

To pursue the question and inquire of the further evidence that the ultimate recovery from the Wewoka Lake Pool, or any other, is substantially independent of the well density would require a length of analysis beyond the confines of this paper. The production history of separate leases and an analysis of the production obtained from each well in terms of the time of completion would provide additional facts. It is deemed sufficient here to have shown that wells create "interference" and that on the basis of the existence of interference, drainage by any well is from the common pool and not alone from the separate lease or drilling unit. Interference exists even between remote and distant parts of a common sourse of supply. Detailed studies of the individual pools here considered, or of others that have come to attention, have shown no evidence that would lead to a conclusion that the recovery from any pool was ultimately greater simply because the pool was drilled in 20-acre spacing rather than 40, or on 10 rather than 20-acres.

If the production data of the Wewoka Lake Pool had not been analyzed in enough detail to show the existence

of interference between wells and leases, a conclusion that the advocates of close well-spacing like to reach might have been the end-point of the analysis. It is a fact that the wells in the Jackson area of the pool drilled on 10-acre spacing obtained an ultimate production *per acre of spacing unit* greater than the ultimate production per acre of spacing unit in the more widely spaced parts of the pool. The wells were unprorated and the more densely drilled area was also the area of higher potential. It is not startling, therefore, to find that the per-acre production attributed to the closely spaced wells was on the average greater than the per-acre production in the other parts of the common source of supply. The existence of interference between wells and leases establishing drainage by all wells from the entire common source of supply amply accounts for the difference in well production due to difference in well density. To not recognize interference and drainage, and to go blindly forward alleging that the recovery (as distinguished from production) was greater in the area of dense drilling due to well density alone, is to commit a serious error. To go beyond all reason and allege that the production from the close-spaced wells due to their capacity to capture from the common source of supply is evidence that 10-acre spacing would have produced a greater ultimate recovery from the common source of supply than would 20-acre spacing would be to compound the error.

Cutler's Rule

There is no discovery of new fact in recognizing that the more densely drilled leases or area of a pool capture the relatively greater share of a common source of supply under circumstances of unprorated operation or under conditions where the allocation formula is essentially on a per-well basis. That fact was first established by W. W. Cutler, Jr.,[2] who announced a tentative rule in the year 1924 as follows:

> "The ultimate productions for wells of equal size in the same pool, where there is interference (shown by a difference in the production decline curves for different spacing), seem approximately to vary directly as the square roots of the areas drained by the wells."

Cutler deserves some credit and honor for having discovered this rule of capture out of purely statistical data on production and without the benefit of the technical information developed in the years following. In 1924 there were only suggestions that the production of oil depended upon the existence of gas-drive or water-drive, or that gas production, reservoir pressure and other reservoir factors were important in determining production and recovery. Unfortunately, there are some who would rather turn Cutler's rule away from the area of its validity and seek to interpret it in terms of percentage ultimate recovery of oil-in-place in pools or seek to use it as a measure of ultimate recovery from separate leases or from spacing units. The language of the rule prohibits such attempts at distortion of fact.

Language of Cutler's Rule

An attempt to interpret Cutler's rule should be made only against the background of the author's comment in his original publication.[2] Nevertheless, Cutler succeeded in the statement of the rule itself to include conditions and premises that should stand as a warning to those who seek to use his rule to prove that "more wells produce more oil." The author of the rule never made a statement that would support such an inference if it were applied to the production from the entire source of supply. It is obvious that Cutler never intended to compare the recovery in one pool with the recovery in another pool on the basis of different well densities. Yet many after him were blind to that injunction and seek to use his rule in a seriously erroneous fashion.[3, 4]

Cutler stated his rule applied to "ultimate production from wells." Therefore, he did not contemplate its application as a measure of recovery of oil initially-in-place in pools or beneath separate leases. The qualifying phrases: "the same pool;" "where there is interference;" and "of equal size" were obviously made a part of the rule by Cutler's understanding that under circumstances of unrestricted production wells were simply "straws in a glass" and must be recognized as such. The first qualifying phrase warned that the production per-well could not be compared as between separate and distinct pools for reasons now well known. The second qualifying phrase controls the application of the entire rule and directs that it can be applied only under conditions where wells drain from the entire common source of supply as evidenced by the existence of interference, which qualifying phrase renders Cutler's rule useful only to measure the relative quantities of oil *captured* by open and unrestricted competition for production. And, finally, the qualification that the rule would apply only to wells of equal size, meaning equal potential capacity, was undoubtedly included for the obvious reason, now well

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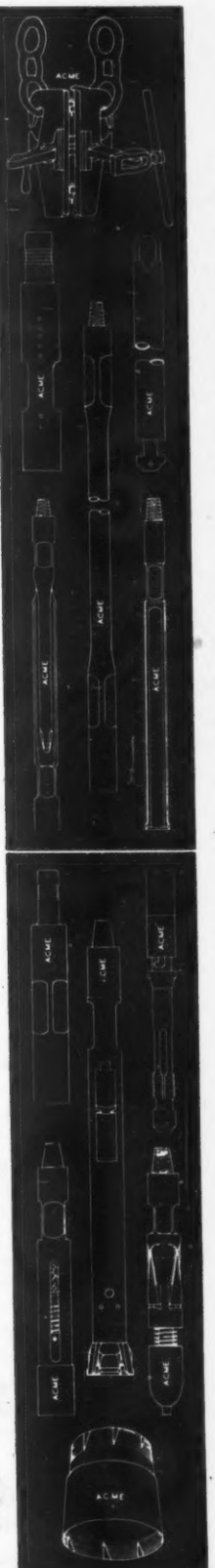

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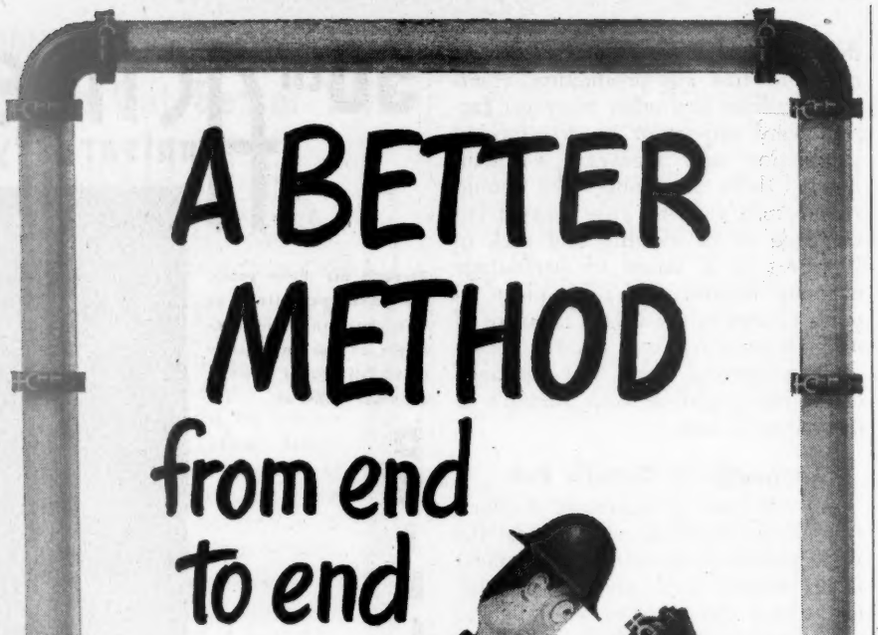

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known, that the potential of a well measures nothing more than the capacity the well has for capture from a common pool.

Much more could be said to throw the myth of dense drilling into true light by reliance on the statements made by Cutler at the time his tentative rule was announced. For example, Cutler observed, "The time of drilling greatly affects the ultimate recovery,"[5] and ". . . . the production of widely spaced wells is more sustained than wells spaced closely."[6] The mere fact that Cutler, in seeking an explanation of his tentative rule, fell into the error of using the phrase, "areas drained by the wells," and then further sought a mathematical explanation involving a square root relationship based upon a notion of reservoir energy consumption, should be no excuse for present-day attempts to cloud the essential principle stated in his tentative rule. If the area drained is for each well the area of the common source of supply, the square root relationship loses all significance. On the other hand, the square root relationship that is used more often to confuse rather than to clarify might well stand even today as purely an empirical approximation expressing the disproportionality that will be created as between separate leases in a common source of supply if one or more leases is more densely drilled than the others, or if the allocation formula under a system of proration does not properly take into account in the allocation of allowed production the relative quantities of recoverable oil-in-place beneath each separate lease in a common source of supply.

Consideration of the energy and distance of drainage features of Cutler's rule as offered by later investigators[7] was unfortunately more directed to the defense of Cutler's rule against those who sought to misinterpret it, rather than a defense of Cutler's rule in the light of principles of modern technology. Those investigators turned their attention to an examination of the physical basis for the square root relationship as expressed by the language involving "area of drainage" in Cutlers' original statement. Not being able to find such a relationship, the fact was overlooked that the substance and essence of Cutler's rule lies in the fact that the area of drainage of any well is the entire area of the pool itself. A notion cannot be turned into fact by a relentless and blind attachment to an idea that rests more in the confusion of fact that it does in fact itself. Oil pools are not as complex and uncertain in behavior as imagination might lead some to believe. The

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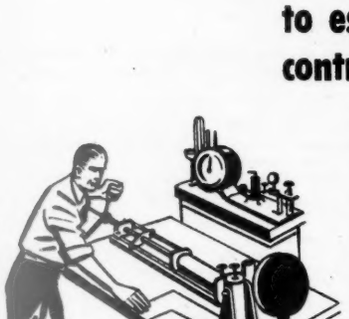

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principles applying to movement of oil and to the utilization of reservoir energy are no different than are the principles that apply to the transformation of energy in any other physical process. For that reason, there is no basis for a square root relationship expressing the recovery to be had from a pool as a function of the number of wells drilled under circumstances where number of wells themselves are the sole and ultimately controlling perimeter.

Summary

Consider the examples here presented or any other examples of pool recovery under variable spacing where the information may be considered reliable. The fact is that the lease most densely drilled, the lease with the higher well potentials, the lease that is allocated oil in excess of the relative amount of recoverable oil-in-place, will, under usual circumstance, ultimately produce the greater proportion of oil from a common source of supply. The "rule of capture" on the basis on which it was established and on the basis on which it was modified in those states having proration policies under conservation statutes had its origin and existence out of consideration of the long established fact that a well or wells drain oil not from limited areas but from an entire common source of supply. More wells will produce more oil from that lease that is more densely drilled as compared to other leases in a pool, but more wells will not necessarily produce more oil from the pool itself.

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6. See Reference (2)—Page 85.
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* * *

The Reporting of Routine Laboratory Core Analyses for Maximum Utility

J. W. YOUNG*, A. S. McLATCHIE*, T. H. MARTIN*

THE present paper describes the method used by the Imperial Engineering Laboratory for the evaluation of core analyses. These methods have been designed with the following purposes in mind:

1. To provide the reservoir engineer with a summary of data in a readily useable form.
2. To present all basic figures in a form that will permit ready detailed checking and correlation with electrologs and other related data.
3. To organize arithmetic data in a form that allows rapid check of calculations.
4. To present derived data in a form that will allow a correlation of special tests, such as pore size distribution, connate water, etc.

Selection of Test Cores

Cores to be tested are selected from the whole suite of cores by a senior member of the staff, each core section being marked and numbered serially. In testing limestone sections one sample is generally taken to represent from 0.5 to 3 ft of core. The average length represented is usually about 0.7 ft. The footage represented is recorded along with the sample position. From 100 to 200 samples may be taken for each 100 ft of diamond core received in the laboratory.

Full size cores are taken wherever possible when testing limestone formations. The diameter being 3.5 in. and the length 3 to 4 in. In areas where the core has been broken, the conventional small core plug (0.75-in. diam by 1 in. long) is used, a vertical as well as a horizontal plug being selected.

The cores are described as to porosity of the rock and the character of the rock. Letters are used to describe the porosity

A. Large vugs
B. Vugs
C. Cracks
D. Fine Pores
E. Impermeable.

Numbers are used to describe the character of the rock as follows:

(1) Dark Grey
(2) Grey
(3) Light Grey
(4) White
(5) Anhydrite
(6) Shales
(7) Iron stains
(8) Pyrites
(9) Sand grains
(10) Hard
(11) Medium
(12) Soft
(13) Oil stains
(14) Pyrobitumen
(15) Stylolite

This method of recording describes the sample with a minimum of writing.

The extraction of the cores is carried out in a large steel Soxhlet type extractor holding about 24 cores. The solvent used is carbon tetrachloride; the cores, after extracting to disappearance of fluorescence, being dried in an oven at 180 C.

Test Procedures

When the cores have been dried completely and have cooled to room temperature they are ready for the routine permeability and porosity determinations, which include:

1. *Weighing:* The cores are weighed, individually, to the nearest 0.1 gram.
2. *Calipering for Volume:* The dimensions of each core are obtained by means of a vernier caliper. Five readings of the diameter and five readings of length of the core are made. The average length and diameter are used for the volume calculation. A simple nomograph may be used to eliminate mathematical errors and speed calculations. The bulk volume determination is accurate to 0.25 per cent. A factor, length/area, which will be used later in the permeability calculations, is also obtained from the original caliper readings.
3. *Porosity Determination:* The method of determination of porosity is a modification of that devised originally by the United States Bureau of Mines[1] using a constant volume cell and a constant volume expansion chamber. It has been described previously.[2]
4. *Permeability Determinations:* The method used for determining small core permeability and large core vertical permeability is the same as described in the reference mentioned above.[2] The apparatus used for radial permeability determinations is of a modified design.[3] After drilling a 0.5-in. hole down the center, the core is held between two rubber end gaskets by means of a movable piston. Air under pressure is passed from the outside to the center of the core. In the case of both vertical and radial permeability measurements, four input pressures are generally used, ranging from 5 cms. mercury to 60 psi. The average of the four calculated permeabilities is generally taken, unless the Klinkenburg effect is to be accounted for.[4]

The Ruska permeameter is used on small cores as a check against the routine instrument, this check being made at regular intervals. Differences between the permeability readings obtained by the two methods may indicate plugging of the fine capillary orifices that are used. On the routine equipment, the laboratory permeameter has a working range of 0.001 to infinity, whereas the range of the Ruska permeameter is from 1 to 3000 millidarcys.

This completes the routine tests that are carried out. A group of representative cores are kept for further tests and the remaining cores are returned eventually to their positions in the core boxes. Serially numbering the cores helps greatly in getting the samples back into the correct position. The cores that have been selected for fur-

*Petroleum engineering laboratory, Imperial Oil Limited, Calgary, Canada.

[1]Taliaferro, Johnson, and Dewees, "A Method of Determining Porosity." U. S. Bureau of Mines R.I. 3352, September, 1937.

[2]Gibbs, Phillips, and Piercey, "Analyzing Large Cores." The Petroleum Engineer, May, 1949.

[3]Unpublished data, Chemical and Geological Company Ltd., Edmonton, Alberta, Canada.

[4]Klinkenburg, "The Permeability of Porous Media to Liquids and Gases," American Petroleum Institute, Drill. and Prod. Practice (1949) 200.

EXCLUSIVE

ther tests keep their original serial number, and, if any small plugs are drilled out of a large core, they are numbered as the original followed by a letter (A), (B), or (C) depending on the number taken. These new numbers are recorded along with any data as to direction of drilling and tests to be run.

The further tests run at present are:

1. Pore size distribution
2. Some chemical analysis of the rock
3. Connate water by restored state technique.[5]

Reporting of Results

A. *General Form*

1. *Number:* Each core is designated by a serial number, the last two figures of which indicate the year (i.e. 150, 250, etc.)
2. *Depth:* Indicates the location of the sample in the well to the nearest 0.1-ft.
3. *Representative of:* The total footage which is represented by the one sample.
4. *Weight:* The weight of the core is reported so that a rapid check can be made on the porosity and density calculations.
5. *Permeability:* The permeabilities are reported as horizontal (or radial) and vertical in the units of millidarcys.
6. *Porosity:* The percentage porosity is given to the nearest 0.1 per cent.
7. *Density:* The densities are reported as "Bulk" density and "True" density and are reported to the nearest 0.01 gram per cubic centimeter.

Changes in "True" density may be used to indicate changes in rock formation such as varying amounts of dolomite in a limestone core. It is also possible that large negative deviations from the average "True" density may indicate the presence of unconnected porosity.

8. Kozeny Constants: the function

$$S_A = \frac{2}{\sqrt{8}}\sqrt{\frac{\phi}{K}}$$

where:

S_A = Surface area per unit of pore volume, ($cm.^2/cm.^3$)
ϕ = Porosity (as decimal)
K = Permeability (units of $cm.^2$) is given in the general core report for both horizontal and vertical permeabilities.

The calculation of S_A is done by means of a straight line nomograph (Fig. 1), which reduces the time required for calculation to a few seconds. In this nomograph, conversion from CGS units to millidarcys is included.

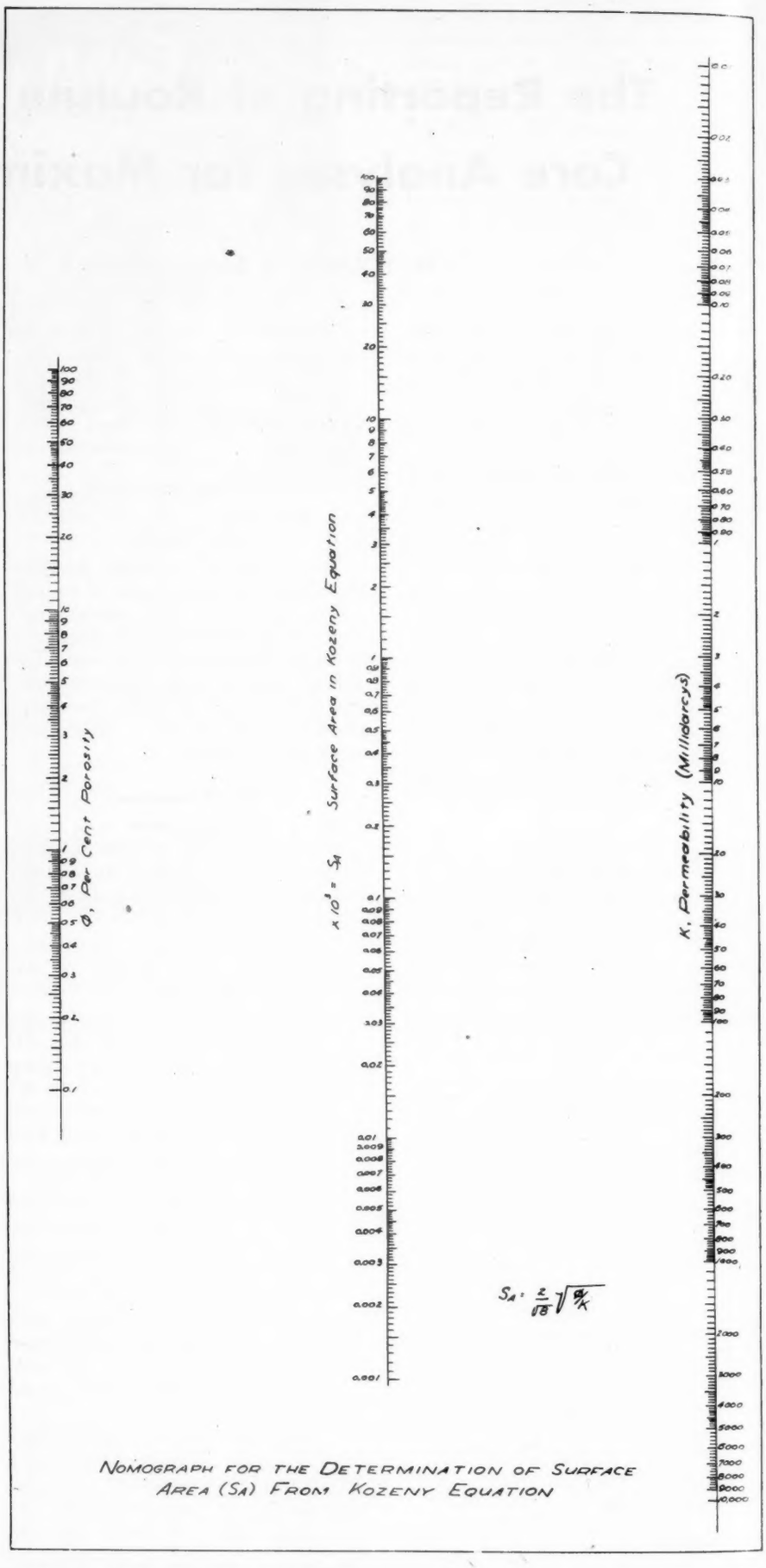
Φ, Per Cent Porosity
x 10³ = S_A Surface Area in Kozeny Equation
K, Permeability (Millidarcys)
S_A = 2/√8 √(Φ/K)
NOMOGRAPH FOR THE DETERMINATION OF SURFACE AREA (SA) FROM KOZENY EQUATION

FIG. 1. Calculation of S_A is done by means of a straight line nomograph which reduces time required for calculation to a few seconds.

[5]Bruce and Welge, "The Restored State Method for Determination of Oil in Place and Connate Water." The Oil and Gas Journal, July 26, 1947, p. 223.

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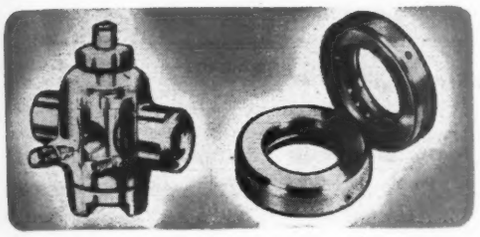

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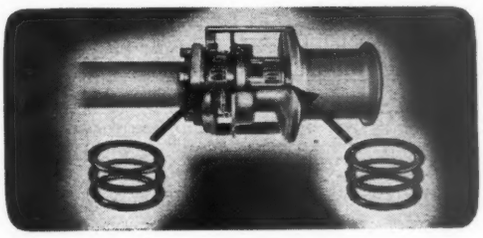

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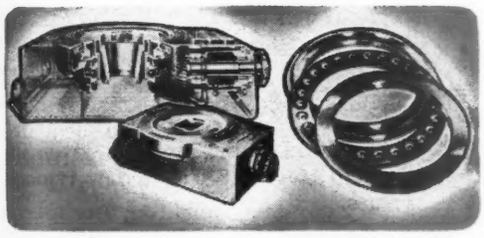

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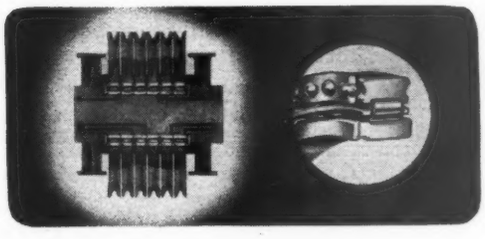

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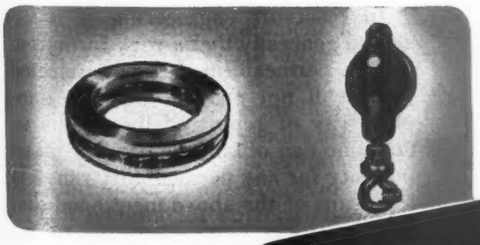

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TABLE 1. General data sheet.

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Depths: 3117.2 to 3142.8

Core number	Depth (feet)	Representative of (feet)	Footage represented	Core weight (gms.)	Permeability (vert.)	Permeability (horiz.) (radial)	Porosity per cent	Density Bulk	Density True	Calculated surface area ($\times 10^{-3}$. cm²/cm³) SA (vert)	Calculated surface area ($\times 10^{-3}$. cm²/cm³) SA (horiz)	Description
31349	3117.2	3116.0-3120.3	4.3	1416.0	0.029	2.06	1.3	2.68	2.71	4.73	0.56	C, E, 3, 11
31449	3120.8	3120.3-3121.3	1.0	871.6	0.003	0.028	1.8	2.68	2.71	17.32	5.67	E, 1, 4, 11
31549	3121.8	3121.3-3126.0	4.7	1392.9	0.044	0.24	4.7	2.62	2.74	7.31	3.13	E, 1, 4, 11
31649	3126.2	3126.0-3128.0	2.0	1510.9	0.131	0.617	1.8	2.68	2.73	2.62	1.21	E, 1, 4, 11
31749	3128.5	3128.0-3133.0	5.0	1175.1	0.007	0.020	2.1	2.69	2.74	12.24	7.23	E, 1, 4, 11
31849	3133.6	3133.0-3134.1	1.1	1435.9	0.084	0.377	3.0	2.65	2.73	4.22	1.99	E, 4, 11
31949	3135.5	3134.1-3136.0	1.9	1445.8	0.404	422	2.4	2.66	2.72	1.72	0.053	C, E, 3, 4, 11
32049	3137.3	3136.0-3138.5	2.5	1403.1	0.090	0.191	1.1	2.68	2.71	2.47	1.75	E, 3, 11
32149	3139.0	3138.5-3139.4	0.9	1454.5	0.829	0.440	2.7	2.62	2.69	1.28	1.75	C, D, 2, 3, 11
32249	3140.1	3139.4-3141.6	2.2	1493.3	0.170	0.371	2.1	2.64	2.70	2.48	1.68	C, E, 2, 3, 11
32349H	3147.7	3141.6-3141.8	0.2	16.5	.....	0.171	4.7	2.57	2.70	.....	3.69	B, D, 3, 11
32449V	3141.7	3141.6-3141.8	0.2	11.9	0.046	.....	Nil	2.68	2.68	.....	.....	E, 4, 11
32549H	3141.9	3141.8-3142.5	0.7	14.1	.....	0.098	3.1	2.60	2.68	.....	3.98	B, E, 4, 11
32649V	3141.9	3141.8-3142.5	0.7	14.2	0.047	.....	1.7	2.64	2.69	4.25	.....	B, D, E, 3, 11
32749H	3142.8	3142.5-3143.0	0.5	10.7	.....	0.003	1.5	2.62	2.68	.....	16.06	E, 3, 11

TABLE 2. Porosity distribution by permeability ranges.

Porosity range	Median (M)	0.00–0.01 mdrcys. Feet (F)	0.00–0.01 mdrcys. F x M	0.011–0.1 mdrcys. Feet (F)	0.011–0.1 mdrcys. F x M	0.11–1.0 mdrcys. Feet (F)	0.11–1.0 mdrcys. F x M	0.01–10 mdrcys. Feet (F)	0.01–10 mdrcys. F x M	10.1–100 mdrcys. Feet (F)	10.1–100 mdrcys. F x M	101–1000 mdrcys. Feet (F)	101–1000 mdrcys. F x M	1000+ mdrcys. Feet (F)	1000+ mdrcys. F x M	Total footages Feet (F)	Total footages %	Total footages Cum. %	Total footages F x M
0–0.99	0.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
1–1.99	1.5	4.3	6.45	2.0	3.00	8.7	13.05	4.8	7.20	...	.....	...	.....	...	.....	19.8	14.04	14.04	29.70
2–2.99	2.5	0.2	0.50	6.9	17.25	8.6	21.50	8.5	21.25	0.2	0.50	2.9	7.25	1.8	4.50	29.1	20.64	34.68	72.75
3–3.99	3.5	3.7	12.95	1.0	3.50	8.9	31.15	5.2	18.20	0.5	1.75	2.4	8.40	0.5	1.75	22.2	15.74	50.42	77.70
4–4.99	4.5	0.5	2.25	0.9	4.05	5.2	23.40	4.0	18.00	1.5	6.75	3.6	16.20	3.2	14.40	18.9	13.40	63.82	85.05
5–5.99	5.5	0.5	2.75	...	.....	2.5	13.75	1.2	6.60	0.7	3.85	2.8	15.40	0.7	3.85	8.4	5.96	69.78	46.20
6–6.99	6.5	...	.....	1.2	7.80	1.9	12.35	...	.....	0.4	2.60	...	.....	4.1	26.65	7.6	5.39	75.17	49.40
7–7.99	7.5	...	.....	3.7	.....	...	.....	3.7	27.75	...	.....	0.3	2.25	1.6	12.00	5.6	3.97	79.14	42.00
8–8.99	8.5	...	.....	...	.....	...	.....	3.6	30.60	...	.....	...	.....	1.0	8.50	4.6	3.26	82.40	39.10
9–9.99	9.5	...	.....	...	.....	0.8	7.60	...	.....	...	.....	...	.....	...	.....	0.8	0.57	82.97	7.60
10–10.99	10.5	...	.....	...	.....	2.2	23.10	...	.....	1.0	10.50	3.5	36.75	...	.....	6.7	4.75	87.72	70.35
11–11.99	11.5	...	.....	...	.....	1.0	11.50	...	.....	...	.....	0.2	2.30	...	.....	1.2	0.85	88.57	13.80
12–12.99	12.5	...	.....	...	.....	...	.....	...	.....	0.3	3.75	...	.....	1.4	17.50	1.7	1.21	89.78	21.25
13–13.99	13.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
14–14.99	14.5	...	.....	...	.....	...	.....	0.6	8.70	2.4	34.80	...	.....	1.2	17.40	4.2	2.98	92.76	60.90
15–15.99	15.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
16–16.99	16.5	...	.....	...	.....	...	.....	...	.....	...	.....	2.0	33.00	...	.....	2.0	1.42	94.18	33.00
17–17.99	17.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
18–18.99	18.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	0.7	12.95	0.7	0.50	94.68	12.95
19–19.99	19.5	...	.....	...	.....	...	.....	...	.....	...	.....	4.5	87.75	1.5	29.25	6.0	4.26	98.94	117.00
20–20.99	20.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
21–21.99	21.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
22–22.99	22.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
23–23.99	23.5	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	.....	.....	.....	.....
24–24.99	24.5	...	.....	...	.....	...	.....	...	.....	...	.....	1.5	36.75	...	.....	1.5	1.06	100.0	36.75
Totals	.....	9.2	24.90	12.0	35.60	39.8	157.40	31.6	138.30	7.0	64.50	23.7	246.05	17.7	148.75	141.0	100.0	.....	815.50

TABLE 3.

Laboratory Report No.

Routine Core Analysis

Well

Summary of Report

Footage cored:.....to.....
Number of samples: 153

Large Cores

Porosity	103
Vertical permeability	98
Radial permeability	94

Small Cores

Porosity	50
Vertical permeability	25
Radial permeability	25

Summary of Results

Distribution by Permeability Ranges

Permeability	Vert. permeability Footage	Vert. permeability Porosity	Horizon. permeability Footage	Horizon. permeability Porosity	Maximum permeability Footage	Maximum permeability Porosity
0-0.01	29.6	3.27%	10.8	2.77%	9.2	2.71%
0.011-0.10	31.1	3.14	10.4	2.94	12.0	2.97
0.11-1.0	35.1	4.59	43.5	3.96	39.8	3.95
1.01-10	20.9	7.80	24.1	4.14	31.6	4.38
10.1-100	8.0	7.35	8.1	15.88	7.0	9.21
101-1000	10.8	15.95	14.8	6.22	23.7	10.38
1000+	1.5	19.50	17.7	8.40	17.7	8.40
Total tested	132.0	5.68%	129.4	5.42%	141.0	5.78%
0.01+	107.4	6.35%	118.6	5.66%	131.8	5.60%
0.1+	76.3	7.66	108.2	5.93	119.8	6.30
1.0+	41.2	10.28	64.7	7.25	80.0	7.47
10.0+	20.3	12.83	40.6	9.10	48.4	9.49
100. +	12.3	16.39	32.5	7.41	41.4	9.54
1000. +	1.5	19.50	17.7	8.40	17.7	8.40

"True" Density

Mean Density 2.718

Ratio of Horizontal to Vertical Permeabilities

Median Ratio of $K_H/K_V = 8.4$

The form of the report is given in Table 1, together with a few typical values.

B. *Summary Data*

1. Distribution of Porosity

The distributions of porosity are of three types:

1. Porosity distribution by *"vertical"* permeability ranges.

2. Porosity distribution by *"horizontal"* (or radial) permeability ranges.

3. Porosity distribution by "maximum" permeability ranges.

In reservoir engineering it is assumed generally that a rock formation with a permeability below a selected value will not produce oil. The simplest way of reporting the results so that one can obtain a weighted mean porosity for any permeability range is by means of the above mentioned distribution. The final summary of results gives the weighted mean porosity above definite permeability values arranged on a 10 fold scale, as well as for any particular permeability range in each 10 fold grouping. All the mean

porosity values are weighted by footage.

The type of form used for porosity distribution is shown in Table 2 for the values of a typical distribution. In the report, actually-used precentages of footage and cumulative percentages are shown for each range of permeability as well as for the total.

These distributions may be used by the reservoir engineer for various purposes:

a. to determine the oil in place.
b. to make use of any particular section of the permeability ranges for oil production calculations.
c. to correlate porosity and permeability within ranges.

2. Ratio of Horizontal to Vertical Permeability

The ratio of the horizontal to vertical permeability is given so that the reservoir engineer will have a check on the method of production. This ratio may be of significance in the evaluation of coning should the question of water flooding of a field arise. The results are reported as the percentage of total samples tested that fall into various arbitrary ranges. The ranges are as follows:

0 - 0.0099
0.01 - 0.099
0.10 - 0.499 etc.

The median ratio is reported.

3. Density Distribution

The distribution of "true density" is calculated, weighted by footage. The weighted mean density, arrived at in this distribution, is of importance in trying to obtain an average density figure for any particular field.

A typical summary sheet is given in Table 3.

Conclusion

In reporting the final results of a complete core analysis the objective has been to give the basic data in a form that is readily useable by the reservoir engineer. This method of carrying out the actual analysis and this method of tabulation of results minimizes the work of the supervisor in checking the results for both mathematical mistakes and equipment errors. One of the most useful checks is that of comparing "true" density figures with the weighted mean "true" density of other wells in the same area. The data as set out in the summary and the routine result sheets provide a convenient method for correlation of results by various test methods.

The writers wish to express their thanks to Imperial Oil Limited—Producing Department — Western Division, Calgary, Alberta, for permission to publish this paper.

* * *

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Plotting Pressure Drop Against Cumulative Production of Gas Fields on Log-Log Paper

HENRY J. GRUY and JACK A. CRICHTON*

In reply to questions concerning the validity of plotting pressure drop against cumulative production for gas reservoirs on logarithmic paper, as set out in our article entitled, "Critical Review of Methods Used in the Estimation of Natural Gas Reserves",* we have prepared the following examples and derivations, so as to clarify the principles involved.

If the pressure (or the drop in pressure) for a closed reservoir containing a perfect gas is plotted against cumulative gas production, a straight line on Cartesian coordinates will result. If the drop in pressure is plotted against cumulative production on logarithmic paper (log-log), a straight line with an angle of 45 deg with the horizontal will result regardless of the size of the reservoir.

Curves 1 and 2 show two examples for perfect gases. In order to show that these are not special cases, one may explore analytical geometry.

The general equation for a straight line on Cartesian coordinate paper is

$$y = mx + b \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where m = slope of the line = tangent ϕ, where ϕ is the angle with the horizontal, and . . . . . (2)

b = the value of the intercept on the Y axis.

In the case of a pressure drop versus production curve the value of "b" is always zero, as there is zero pressure drop at zero production and the equation becomes,

$$y = mx \quad . \quad . \quad . \quad . \quad . \quad (3)$$

then, $\log y = \log m + \log x \quad . \quad (4)$

Since log m is a constant for any particular case,

$$\log m = c \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and $\log y = \log x + c \quad . \quad . \quad (6)$

Equation (6) is a straight line on logarithmic paper having a 45 deg angle with the horizontal. Using equations (2), (4), and (6) we have assigned values to the Constant, c, which fixes the value of m and ϕ, and solved for x at several different values of y. As shown on Curves 3 and 4 you will note that a straight line results both on Cartesian and logarithmic paper, and that on the logarithmic paper all the lines make an angle of 45 deg with the horizontal.

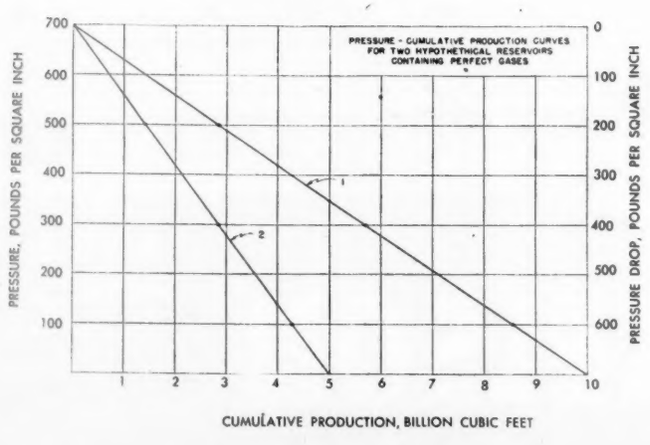
EXCLUSIVE

TABLE 1. *Data for Curves 1 and 2 Hypothetical Gas Reservoir No. 1*

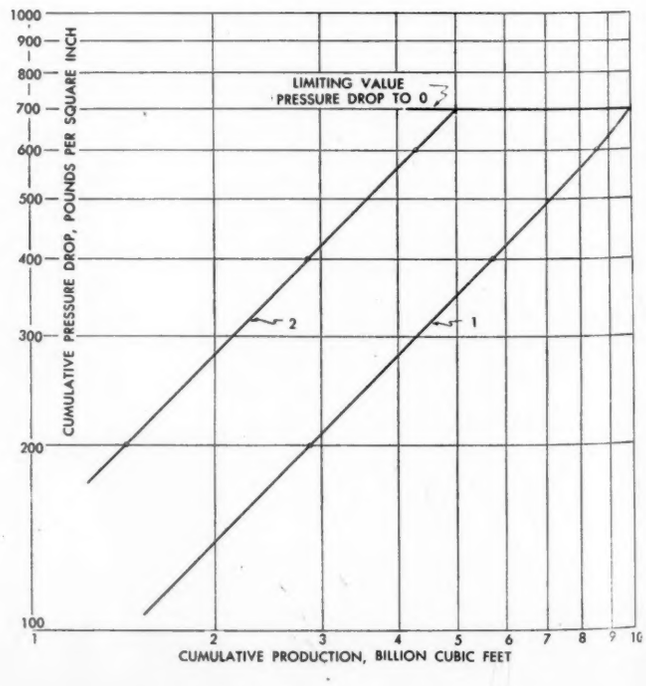
Pressure, psi	Pressure Drop, psi	Cumulative Production, Billions of Cubic Feet
700	0	0
500	200	2.857
300	400	5.714
100	600	8.571
0	700	10.000
Hypothetical Gas Reservoir No. 2		
700	0	0
500	200	1.429
300	400	2.857
100	600	4.286
0	700	5.000

When used in estimating gas reserves for a closed reservoir, this curve is extrapolated to the drop in pressure required to reach the abandonment pressure. If the angle with the horizontal is less than 45 deg, the presence

CURVE 1.

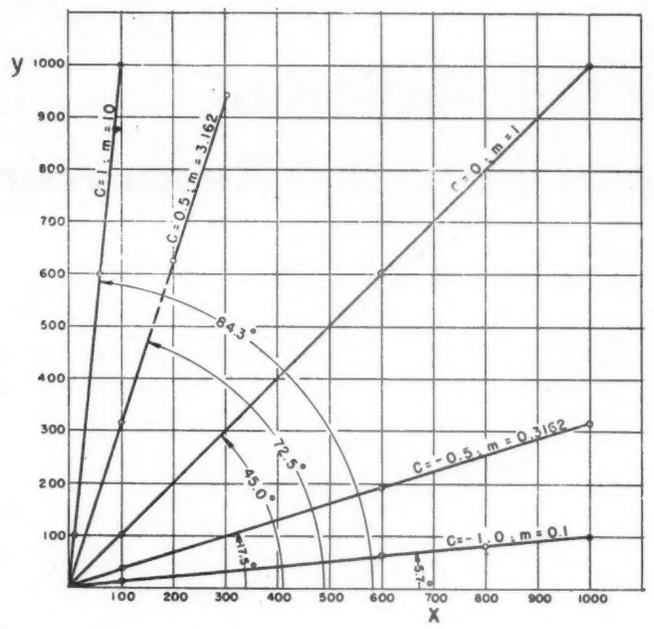

PRESSURE - CUMULATIVE PRODUCTION CURVES FOR TWO HYPOTHETICAL RESERVOIRS CONTAINING PERFECT GASES
PRESSURE, POUNDS PER SQUARE INCH
PRESSURE DROP, POUNDS PER SQUARE INCH
CUMULATIVE PRODUCTION, BILLION CUBIC FEET
1
2

CURVE 2.


LIMITING VALUE PRESSURE DROP TO 0
CUMULATIVE PRESSURE DROP, POUNDS PER SQUARE INCH
CUMULATIVE PRODUCTION, BILLION CUBIC FEET
1
2

†Petroleum Engineers, DeGolyer and MacNaughton, Dallas, Texas.

*Published in The Petroleum Engineer, October, 1948, pages 208 to 220, inclusive.



CURVE 3. Showing the various angles obtained on coordinate graph paper.

of a water drive is indicated. An angle with the horizontal greater than 45 deg can result from an expanding gas-cap, or erroneous pressure or production data due to incomplete pressure build-up, or unreported gas production. Curve 5 shows the effect of deviation of gas from Boyles law where Z equalled 0.812 initially.

The use of logarithmic paper in plotting pressure drop against cumulative production for oil fields is discussed at length in the U. S. Bureau of Mines Bulletin R.I. 3634, April, 1942. Other common uses of logarithmic paper include gas well potential and deliverability curves, and friction loss curves for gas flow strings. * * *

TABLE 2. *Data for Curves 3 and 4*

$y = mx$

$\log y = \log x + c$

$c = \log m$

$m = \text{tangent } \phi$

If $c = 1$, then $m = 10$ and $\phi = 84.3°$

Let y =	then x =
10	1
100	10
600	60
1000	100

If $c = 0.5$, then $m = 3.162$ and $\phi = 72.5°$

Let y =	then x =
3.162	1
31.62	10
316.20	100
632.40	200
948.60	300

If $c = 0$, then $m = 1$ and $\phi = 45.0°$

Let y =	then x =
10	10
100	100
600	600
1000	1000

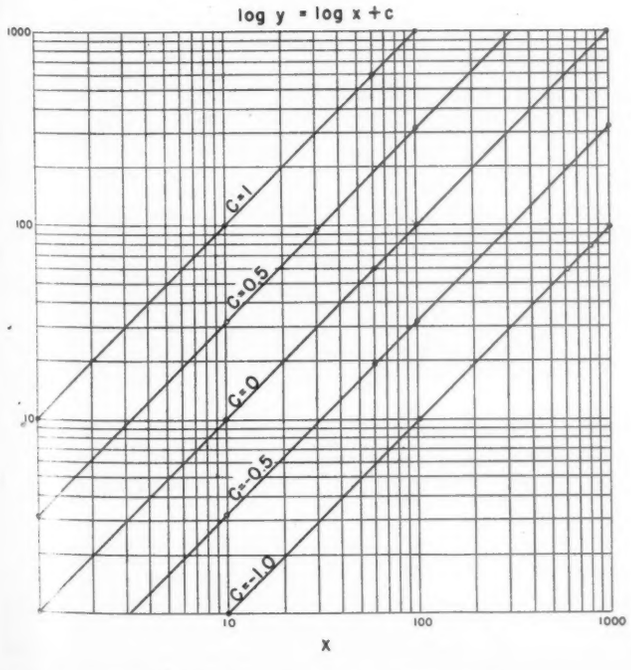
If $c = -0.5$, then $m = 0.3162$ and $\phi = 17.5°$

Let y =	then x =
3.162	10
31.62	100
189.72	600
316.20	1000

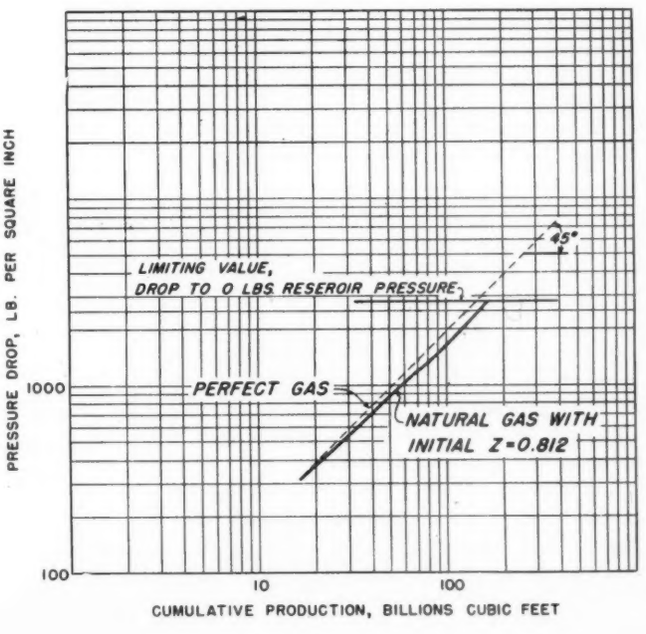
If $c = -1.0$, then $m = 0.1$ and $\phi = 5.7°$

Let y =	then x =
1	10
10	100
60	600
80	800
100	1000

CURVE 4. Showing how all coordinate lines on curve three become parallel lines with 45 deg angles when plotted on logarithmic (log-log) paper.



CURVE 5. Effect of deviation of gas from Boyles law for a constant volume reservoir.



EXCLUSIVE

Chart for Calculation of Net Permeability of Invaded Reservoirs

JACK G. ROOF†

ANY decrease in the permeability of the formation immediately surrounding the well bore, such as is caused by invasion of mud or mud filtrate, affects significantly the effective or net permeability of a reservoir.

If the permeability of the formation is a function only of the radial distance from the center of the well, the permeability may be expressed as $K = K(r)$. In this case, the net permeability K_n of the zone between the well of radius r_w and some external circle of radius r_e is given in the equation:

$$\frac{\ln (r_e/r_w)}{K_n} = \int_{r_w}^{r_e} \frac{dr}{K(r)\, dr} \quad . \quad (1)$$

If the permeability has constant, but different, values in each of two concentric zones in contact at radius r_o, this equation yields

$$\frac{\ln (r_e/r_w)}{K_n} = \frac{\ln (r_o/r_w)}{K_1} + \frac{\ln (r_e/r_o)}{K_2} \quad . \quad . \quad . \quad . \quad (2)$$

from which one may derive the relationship

$$\log \log (r_o/r_w) + \log \left[\frac{1}{K_1/K_2} - 1\right] - \log \log (r_e/r_w) = \log \left[\frac{1}{K_n/K_2} - 1\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Addition charts based on equation (3) have been found to be quite useful in calculating net permeabilities in concentric radial systems. Fig. 1 is a typical chart.

An example of the use of this chart is indicated by the broken lines shown thereon, for which

$r_o/r_w = 2.2 \quad r_e/r_w = 500 \quad K_1/K_2 = 0.25.$

From the chart K_n/K_2 is estimated to be 0.72 or 0.73. Direct calculation by logarithms gives the answer as 0.724.

If it is desired to consider three or more concentric zones of permeability, the net permeability of the two innermost zones may be calculated, and then this combined zone may be considered as a single unit in calculations with the third zone.

Obviously, if any three of the ratios r_o/r_w, r_e/r_w, K_1/K_2, K_n/K_2 are known, the fourth may be estimated from the chart.

†Publication No. 9, Exploration and Production Research Division, Shell Oil Company, Houston, Texas.

* * *

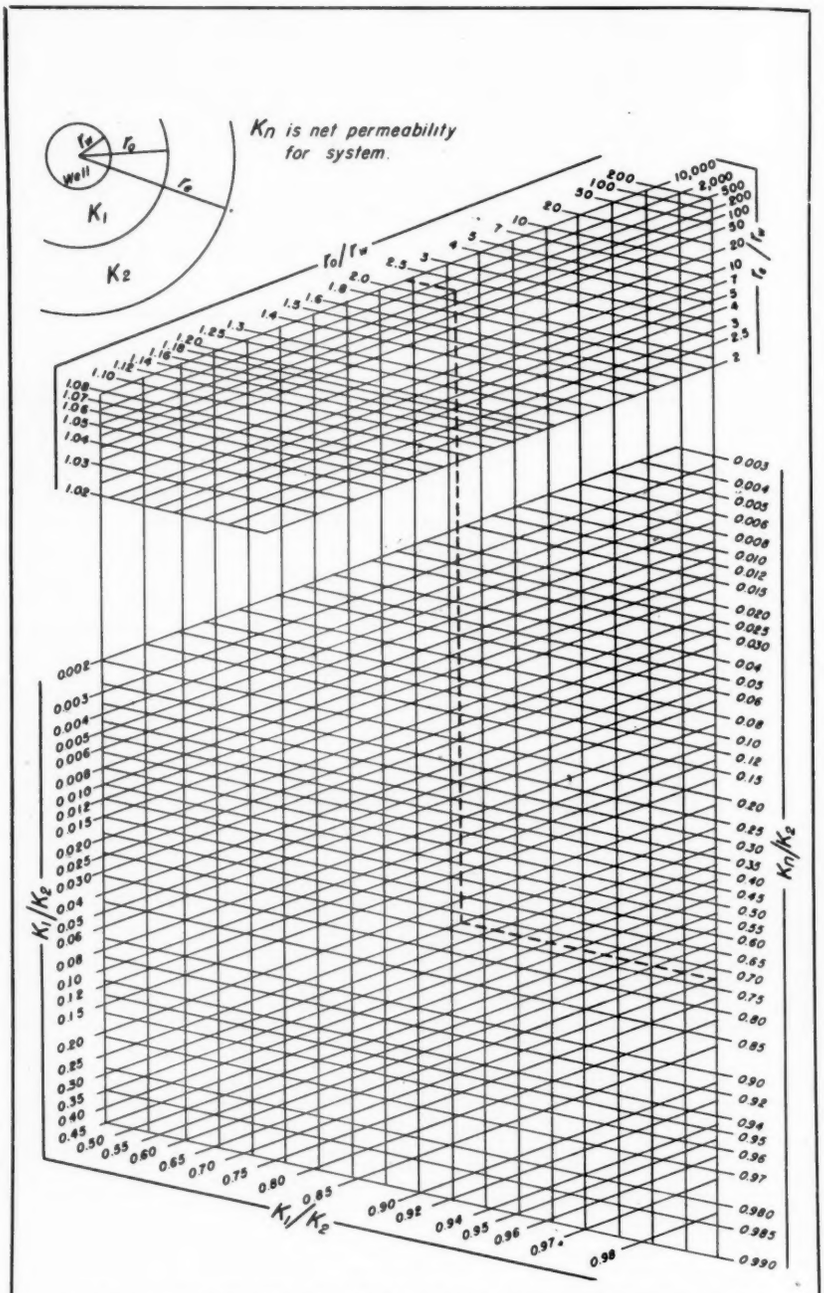


FIG. 1. CHART FOR CALCULATION OF NET PERMEABILITY OF RADIAL-FLOW SYSTEM HAVING ZONE OF LOW PERMEABILITY SURROUNDING WELL.

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NEWS

Peru Grants Permit To Oil Companies

The Peruvian Government has granted permits to Richmond Petroleum Company and International Petroleum Company, Ltd. to carry out preliminary exploration operations in the northern parts of the country. Conorado Petroleum Corporation took out permits early this year and is now conducting surface geological and gravity-meter studies. The Peruvian coastal region will probably be the next to be explored.

The most important area is the Sechura desert lying to the south of Peru's present principal production, which is operated by International around Talara. Conorada operations are centering on the edge of an area extending over about 2,000,000 acres.

Oil Land Available

The Bureau of Land Management is offering for lease sale 160 acres of oil land 30 miles northeast of Bakersfield, California. The land is in the Semitropic field, and is offered in one parcel totalling 160 acres.

Also available is Utah land amounting to 440 acres in the Farnham oil field, 12 miles southeast of Price, Utah. The Utah land is offered in 3 parcels. Awards will be made to qualified bidders of the highest cash amounts per acre as a bonus for the privilege of leasing the lands under the act of 1920.

ASME Petroleum Conference Plans Complete

Plans for the 1950 petroleum mechanical conference sponsored by American Society of Mechanical Engineers are complete. Registration for the four-day conference will be held Sunday afternoon, September 24 at Hotel Roosevelt, New Orleans, Louisiana. Besides the technical sessions there will be a luncheon Monday noon, September 25, at which H. J. Voorhies, general manager, Baton Rouge refinery, Esso Standard Oil Company, will deliver an address on "The Significance of a Cost Reduction Program in Petroleum Refining Operations." Monday night will be given over to a fellowship party.

Bruce K. Brown, president, Pan Am Southern Corporation, New Orleans, will be the chief speaker at a banquet Tuesday night. His address will be "Petroleum in Peace and War." Thursday a field trip to the Freeport Sulfur Company plant at Port Sulfur, Louisiana has been arranged.

E. W. Jacobson, Gulf Research and Development Company, is chairman of the ASME and J. M. Sexton, M. W. Kellogg Company, is secretary.

The theme of this fifth annual conference is "Cost Reduction." Technical sessions for those interested in production will be:

Casing Design and Percussion Drilling Session. Monday, 2 p.m., September 9, Room E. Chairman, R. K. Winters, production engineer, Atlantic Refining Company, De Ridder, Louisiana; vice-chairman, J. H. Rambin, Jr., assistant division manager, The Texas Company, New Orleans, Louisiana.

"Design of High Strength Casing Strings" by B. E. Curran, chief engineer, Kerotest Manufacturing Company, Pittsburgh, Pennsylvania.

"Allowable Loads on an Unsupported Casing Column" by J. A. Reed, II, associate petroleum engineer, and H. H. Meredith, Jr., supervising petroleum engineer, Humble Oil and Refining Company, Houston, Texas.

"The Bassinger Rotary Percussion Drill," Robinson Brown, supervisor of engineering design, Southwest Research Institute, San Antonio, Texas.

Oceanography. Tuesday, 9 a.m., September 26, Room E. Chairman, Earl Kipp, chief engineer, The California Company, New Orleans, Louisiana; vice chairman, C. L. Graves, manager of offshore construction, J. Ray McDermott and Company, Inc., Harvey, Louisiana.

"Gulf Coast Hurricane Design Data" by A. H. Glenn, director, A. H. Glenn and Associates, New Orleans, Louisiana.

"Engineering Aspects of Oceanography As Related to Offshore Operations" by Professor Dale F. Leipper, acting head, Department of Oceanography, A. & M. College of Texas, College Station, Texas.

Production Materials. Tuesday, 1:45 p.m., September 26, Room E. Chairman, J. M. Roberts, Dean of Engineering, Tulane University, New Orleans, Louisiana; vice chairman, B. Dykstra, area manager, Shell Oil Company, New Orleans, Louisiana.

"Study of 9 Per Cent Nickel Tubing in Corrosive Condensate Wells" by L. W. Vollmer, director, and C. N. Bowers, section head, M. & P. Chemistry Division, Gulf Research and Development Company, Pittsburgh.

"Protection of Structures Exposed to Sea Water" by B. B. Morton, corrosion engineer, Development and Research Division, International Nickel Company, New York.

"Properties and Applications of Ductile Cast Iron" by M. Kuniansky, vice president, Lynchburg Foundry Company, Lynchburg, Virginia.

Well Problems. Wednesday, 9 a.m., September 27, Room E. Chairman, C. A. Langner, petroleum engineer, Humble Oil and Refining Company, New Orleans, Lousiana; vice chairman, Waldemar S. Nelson, consulting engineer, Bedell & Nelson, New Orleans.

"Well Performance in Relation to Gas Transmission Line Requirements"

An Anglo-Canadian Oil Company crew cleaning paraffin out of a Turner Valley well. Paraffin cutting knives are run in the well on a steel measuring line and pulled out by a small hoist mounted in the truck (right). S. F. Shaw, consulting engineer from San Antonio, Texas, discusses the progress of the job with the crew.

by E. R. Phillips, production engineer, Transcontinental Gas Pipe Line Corporation, Houston, Texas.

"Gas Propulsion As Applied Today to Oil Production" by D. G. Knox, gas lift engineer, National Supply Company, Torrance, California.

"Design of Hydraulic Pumping Equipment" by P. J. Donnelly, manager, pump department, W. C. Norris Company, Tulsa, Oklahoma.

Production Research. Wednesday, 1:45 p.m., September 27, Room E. Chairman, Roy T. Sessums, Dean of Engineering, Louisiana Polytechnic Institute, Ruston; vice chairman, E. L. Rawlins, chief engineer, Union Producing Company, Shreveport, Louisiana.

"The Effects of Patents on Petroleum Production and Development" by Dr. Paul F. Hawley, patent supervisor, Stanolind Oil and Gas Company, Tulsa, Oklahoma.

"Fatigue Testing and Development of Drill Pipe-To-Tool-Joint Connections" by W. S. Bachman, engineer, research engineering department, Hughes Tool Company, Houston, Texas.

"Lubricated Plug Valves for Drilling and Well-Head Service" by E. E. Hedene, chief engineer, Merco Nordstrom Valve Division, Rockwell Manufacturing Company, Pittsburgh.

Gulf Sets Up New Department

Gulf Oil Corporation is setting up its crude oil purchasing and pipeline transportation activities as a separate department, with J. H. Russell, vice president, Houston, Texas in charge. He will report direct to S. A. Swensrud, president, at Pittsburgh, Pennsylvania.

At the same time Ben C. Belt, vice president, will be in charge of crude oil production activities formerly handled by Russell in the Houston division. Prior to this change the crude oil purchasing and department activities had been handled by the production department.

"We feel that the new organizational set-up will make it possible for the company to give even better service in its dealings with the many producers from whom it purchases oil, and in providing connections to and outlets for new wells and fields," Swensrud said.

Gulf, a major producer of crude and liquid products, also is a major purchaser of crude in the United States, most of it being obtained from independent producers. Its pipe line system comprises more than 10,000 miles, and the company operates eight refineries, all lying east of the Rocky Mountains.

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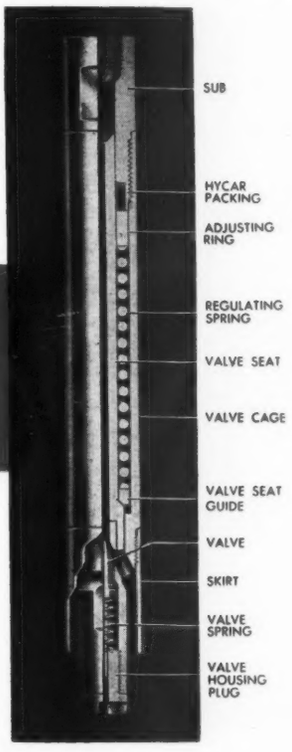

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Otis removable Bottom-Hole Regulators choke back well pressures deep in the string so that the travel up the tubing re-heats flow temperatures to safe, workable limits at the surface. Type DJ Regulators (J Mandrel Assembly and Landing Nipple and D Regulator) are recommended for high-pressure wells with 185°-350° temperatures. Type S Mandrel Assemblies and Landing Nipples are recommended for extra-high-pressure wells where several regulators are required to reduce surface pressures. Type B Mandrel Assembly is for wells not having previously-installed Otis J or S Landing Nipples. Contact one of these Otis offices for complete details . . .

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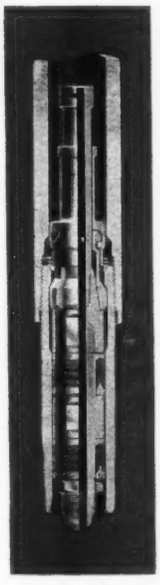
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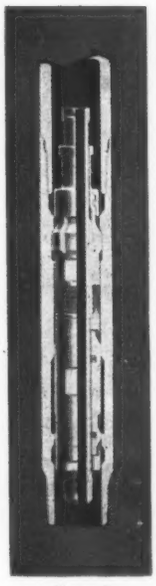
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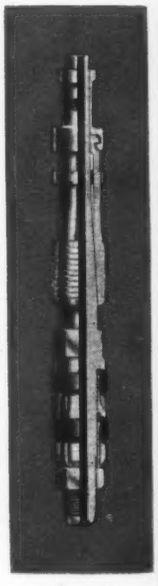
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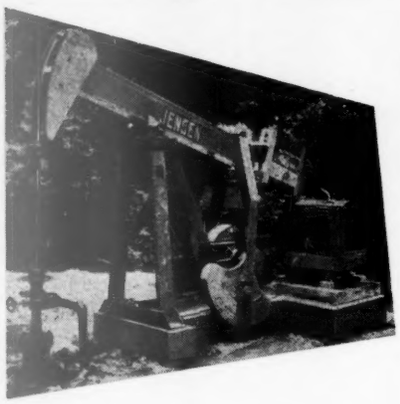
PRESSURE CONTROL OTIS SERVICE — EQUIPMENT

Elk Hills Production Runs 8000 Bbl a Day

A production of 80,000 bbl per day would be available from Elk Hills Naval Petroleum Reserve in California, if needed by the military. This information was released by NPR director, Commodore Greenman, just returned from inspecting this field, which has 88 wells in the Stevens Zone and 570 in the Shallow Zone ready to produce. Most of the 8000 bbl per day now being produced from Elk Hills is turned over to the Army for movement to Japan for use by occupation authorities there.



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Depth Records Set in Texas and Louisiana

Two depth records have been set recently, one in Texas and one in Louisiana. Sinclair Oil and Gas Company claims it has set the unofficial production depth record for Texas oil wells with its No. 1-E June Sanders in Midland, County, Texas drilled to 13,290 ft. Situated in the Sweetie Peck field; the new well flowed 909 bbl of oil from perforations between 13,245-290 in the Ellenburger.

The old record of 13,250 ft was set March 4 by General American Oil Company's field discovery, a quarter mile south of the Sinclair well.

The Shell Oil Company definitely has established the deepest oil production in South Louisiana with completion of a producer on the north flank of Weeks Island Dome, Iberia Parish, at a total depth of 15,361 ft. The well is the No. 2 Weeks Gall State Unit 2, which flowed 247 bbl of oil daily through an 8/64ths-in. choke from 15,122 to 15,137 ft.

Drilling Company Set Up

A new oil company has been incorporated with headquarters at Shawnee, Oklahoma. Penn Drilling Company, Inc., name of the new firm, is a drilling contracting and operating incorporation. Incorporators are, John M. Halko, Keith Houser, and Keith A. Bovee.

Venezuelan Production

The Colon Development Company, Ltd., has reported that it produced 348,593 bbl of crude oil in Venezuela during the 4 weeks ending July 31, 1950.

Saudi Arabian Production

Crude oil production in Saudi Arabia during July amounted to 17,-315,765 bbl, or an average of 558,573 bbl per calendar day, it was announced by the Arabian American Oil Company. Crude oil production for the first seven months of 1950 amounted to 105,845,358 bbl, an average of 499,271 bbl per calendar day. This figure was up slightly from the 16,879,210 bbl, an average of 562,-640 bbl per calendar day produced in June.

Opens Canadian Offices

The Geological Survey of Canada is setting up offices in Calgary to cover the western provinces and the Northwestern Territories for the Canadian Department of Mines and Resources. Announcement was made by Dr. George S. Hume, director general of technical services. The new offices will have a staff of four or five geologists.

Activity in Dakotas

Wildcatters are moving into the Dakotas. The Morton Oil and Amerada Petroleum Companies have stuck drill pipe at 2370 ft at a well, and have staked another test, both in Meade County, South Dakota.

In North Dakota, Plymouth Oil No. 1 Patented, Mercer County, was drilling tight below 8300 ft. Roeser and Pendleton have begun the No. 1 Weber in Emmons County. Several other companies are staking wildcat tests many as deep as 10,000 ft.

New Firm Established

Bell and Burden, Inc., drilling contractors, has opened new offices in Los Angeles, California. Offices will be in the National Oil Building, 609 South Grande Avenue. A. H. Bell, is president and D. H. Burden is vice president, secretary-treasurer.

Crude Production In Iran

Production of crude oil in Iran for the month of June, 1950 amounted to 2,694,000 long tons. Total production for the period January 1-June 30, 1950 was 15,692,000 long tons. The production figure for May, 1950 has been amended, and is now 2,716,000 long tons, making 12,998,000 long tons for the period January 31-May 31.

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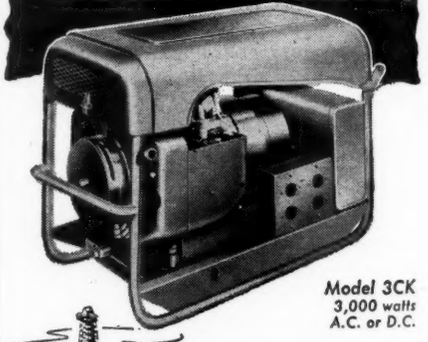

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WHAT'S DOING IN DRILLING

Texas Gulf Coast Adds Two New Pools

The Texas Gulf Coast recorded two wildcat discoveries recently. One was the Commercial Petroleum and Transport Company No. 1 John Kulcak, in Wharton County. The wildcat was completed to flow 170 bbl of oil daily through an 8/64-in. choke from 6562-68 ft. Gas-oil ratio was 477 to 1.

In Brazoria County, Amerada Petroleum has completed its No. C-1 State to flow 50.5 bbl of oil, two and a half barrels of mud, and one barrel of salt water through a 12/64-in. choke on a 20-hr test from 7122-36 ft. Tubing pressure was 2450 lb.

Colorado Gas Well

Amerada Petroleum Company has reported a new strike in the Feep Creek area of Carbon County, Colorado. The new well made a gas flow of 10,000,000 cu ft daily from a tertiary sand zone between 2462 and 2474 ft. It is being deepened to test the Cloverly sands.

Stake Garza Test

Fanning its exploratory efforts out from the active Canyon Reef play of Scurry County, Texas, Cities Service Oil Company (Delaware) has announced location of a 9000-ft Ellenburger test in Garza County. The test is Stoker No. 1, center, near the county seat town of Post. Nearest production to the wildcat is the Post pool, which produces from the San Andres lime.

Persistent Redrilling Brings Continued Success

A group of persistent oil company engineers have put a new twist on an old saying in their operations in the Rincon oil field along the Pacific Coast shoreline just north of Ventura, California. To them the old saw should read, "If at first you do succeed, try, try, again!" Back in 1931 the engineers of the General Petroleum Corporation built an expensive pier 650 ft out from the shore and drilled a well right in the ocean floor. It was one of the earliest attempts at over-water drilling, now relatively commonplace in the oil industry.

In March 1938, when the well began to run dry, they drilled what was in effect a new oil well but used the old well to take them down the first 2610 ft because of the high cost of over-water drilling sites. The new well produced oil until November 1949. By that time the pool tapped by the second well was virtually depleted. So the engineers went back a third time and drilled again. The third well started 877 ft down in the first well. At that point the drill was angled off or slanted so that the lowest point of the third well was 500 ft to the southwest of the lowest point of the original well and a considerable distance from the bottom of the second well.

Recently the third well began to produce oil from a depth of 2640 ft—19 years and one month after the original well was completed. Initial production rate of the third well was 258 bbl daily, better than 100 bbl per day more than the original well produced at the start. To date, the engineers' persistence has produced better than 440,000 bbl from these wells at current prices close to $1,000,000 worth of crude oil.

Plans Kansas Test

An Arbuckle test for Rooks County, Kansas has been announced by Cities Service Oil Company (Delaware). The test well is Benedict No. 1, about 5 miles east of Plainville, Kansas. Projected depth is 3700 ft maximum. Nearest production to the test is the Nettie pool, 1½ miles southwest, which produces from the Arbuckle and Kansas City.

Obtains 10th Viking Well

Superior Oils—General Petroleum, Kroy Oils, and Jupiter Oils—has obtained its 10th Viking sand oil well 20 miles southeast of Edmonton at Joseph Lake. On tests run at Superior-Joseph Lake No. 12, half a mile north of the No. 10 producer, gas was reported at the rate of 3,600,000 cu ft a day and 60 ft of oil in 20 min at 3276 to 3287 ft. A subsequent test, from 3287 to 3292 ft sent oil to the surface in 33 min and gave gas at the rate of 170,000 cu ft a day.

Shut-In Wells Put Back on Production

Standard Oil Company of California has announced that it is returning to production a number of shut-in wells. The reason for this action, it was stated, was to offset anticipated loss early in August of a major part of Standard Oil Company's production in the Elk Hills Naval Reserve, in accordance with recent action taken by the Navy.

Shallow Sand in Deep Pool

Shell Oil Company has opened a new shallow sand in one of South Louisiana's deepest oil-producing areas. On the Weeks Island Dome, Iberia Parish, Shell Oil No. A-7 Weeks Island-State flowed 127 bbl of oil daily through 10/64-in. choke from 3742-50 ft. This new well is one and one half miles west of Shell No. 1-A John C. Smith, which at one time was the world's deepest producer. It produces from 14,243-55 ft.

Egyptian Well Discovered

A well brought in recently at Hurghada, Egypt's oldest commercial oil field gives greater hopes for increased production in that part of the world. Efforts to rejuvenate the 37-yr field, where 43 wells have been pumping at an average rate of about 23 bbl per day, are understood to include deeper drilling. This new well was tested over two weeks with a ¾-in. choke averaging 250 bbl per day.

Arkansas Wildcat Found

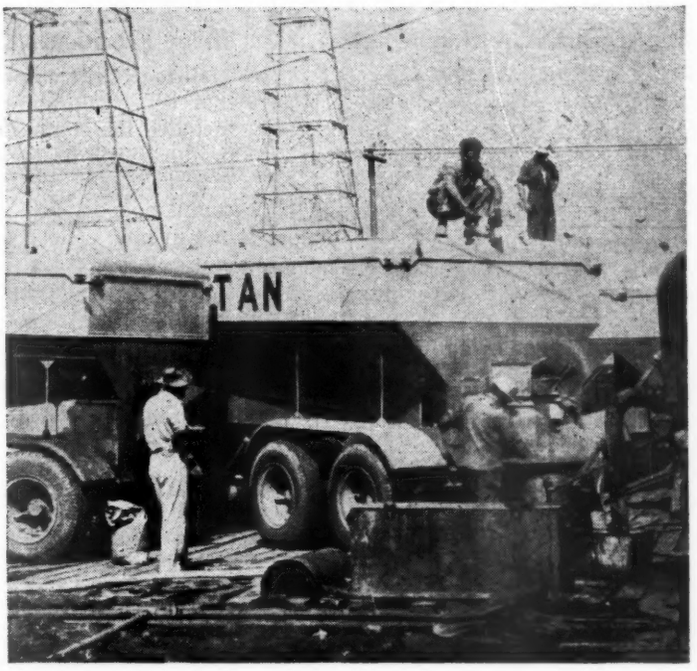
Claude A. Lee has completed a discovery well at his wildcat test in Union County, south Arkansas. His No. 1 E. V. White is producing from perforations in the Meakin sand at 2476-79 ft. Initial production showed the well gaging 15 bbl of 24-gravity oil per day plus 961,000 cu ft of gas flowing through 3/16-in. choke. The well has a gas ratio of 64,000 to one.

Rotary Rigs Operating in Oil Fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Okla. Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texas
First	2282	516	144	373	156	210	742
Second	2280	498	148	371	157	112	746
Third	2325	525	138	414	153	212	746
Fourth	2316	516	135	425	156	210	741

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

When bottom-hole conditions spell DANGER



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Sohio and Providence Enter New Drilling Contract

The Sohio Petroleum Group and the Sasketchewan government have entered into an agreement whereby an active drilling campaign will be carried out, that may call for expenditures in excess of $6,000,000 by the spring of 1953. The announcement was made by J. H. Brockelbank, resources minister.

Under the new contract, Sohio will pay rentals of 30 cents per acre for the first year, and 40 cents per acre during the second year. The group has the right, under the agreement, to surrender any land in good standing before the contract is completed. The agreement also provides for a royalty to the government of up to 15 per cent, and crown reserves are established equal to 25 per cent of the crown mineral area.

Two-Zone Well in Katie

Carter Oil Company has a two-zone well in the Katie pool of Garvin County, Oklahoma. It is the No. 1 Pickens Unit, which flowed 51 bbl of oil in 17 hr through a 1/4-in. choke from the Hart sand. Gas-oil ratio was 10,300-to-1. Plug-back depth is 6944 ft with perforations at 6802-18 ft and 6228-35 ft.

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Three Producers Drilled

Bishop Oil Company has reported that its second quarter development included the completion of 2 wells to production in the Redwater oilfield of Alberta Province, Canada, and the completion of one well to production in Cuyama Valley, California. A second well was being drilled in Cuyama Valley as the period closed. One well was abandoned as a dry hole.

Panther Creek Gets Offset

Republic Natural Gas Company has completed a Garvin County, Oklahoma, Panther Creek pool offset at its No. 1 Burch. Drilled to 7620 ft with casing at 7528 ft, the Gibson sand was perforated with a series of holes at 7363 to 7437 ft, and on last production test flowed 165 bbl of oil in 22 hr through a 1/64-in. choke. The Hart sand was opened and flowed 53 bbl of oil in 8 hr through a 14/64-in. choke.

Two Colorado Extensions

Fort Morgan and Merino fields in northeast Colorado, new oil fields, have both been given extensions. At Fort Morgan, the J. M. Huber Corporation and Adams Drilling Company south extension wells flowed 25 bbl of oil in one hour and gas at the rate of 2,500,000 cu ft daily in a test of the Muddy sand. The discovery well is pumping 20 to 52 bbl of oil an hour.

The west extension well to the Merino field, drilled by Trigood Oil Company, had 2900 ft of oil in the hole after a one-hour drill stem test of the Dakota sand. The Merino discovery well was completed last week for 280 bbl of fluid daily, 88 per cent oil and the rest water. Both the Fort Morgan and Merino fields are in the Denver Basin, which covers parts of Nebraska, Wyoming, and Colorado.

Biggest Whittier Well

Union Oil Company has its best well to date on the Sansinena lease at Whittier, Los Angeles Basin, California. The company's No. 19 came in from 3350 ft flowing 395 bbl of 23 gravity oil and 80,000 cu ft of gas daily.

Leduc Oil Field Broadened

A new extension well has been added to Leduc oil field, Canada. More than a mile southeast of the D2 oil pool discovered by Leduc Calmar Oil Company at Leduc, an Edmonton group, Miller, Roberts, and Pyrcz have reported oil at its Dewar No. 1. The Leduc Calmar pool was in itself a mile and a half southeast extension to the main production at Leduc, meaning that the Dewar No. 1 is two and a half miles southeast of the field. Oil hit the surface in 49 min.

Peru Contracts to Attempt Deeper Production

Empresa Petrolera Fiscal, Peruvian government oil company, has signed a contract with Dunlap and Graham of Long Beach, California for the drilling of deep tests of 7500 to 9000 ft in the Zorritos field in Northern Peru. Purpose of the wells is to test the deeper horizons in that region, as production of the Miocene Zorritos formation is nearing exhaustion. Work has already begun.

Drilling has begun in the Organos field in the hope of increasing production. Use of rotary equipment to reach deeper formations is under consideration.

Lakeside Field Extended

Stanolind Oil and Gas Company has completed its No. 1 Lacassine, to extend the Lakeside field, Cameron Parish, South Louisiana. The new extension flowed 22.47 bbl of condensate daily plus 1,120,000 ft of gas through 3/16-in. choke from 9974-90 ft.

Velma Field Offset

Sinclair Oil and Gas Company has completed a large Velma sand producer at its No. 14 Haines in Stephens County, Oklahoma. The new well is in the east extension of the Velma field of Stephens County. From perforations at 5444-56 ft and open hole at 5479 to 5628 ft, the well flowed 672 bbl of 31.3 gravity oil in 15 hr through a 3/4-in. choke. Daily gas volume was 470,000 cu ft.

Elk City Well Completed

In the Elk City pool, Beckham County, Oklahoma, Shell Oil Company has completed another large producer. It is the No. 1 Pyle. From plugged total depth of 10,040 ft, the well flowed 682 bbl of oil and 1,164,000 cu ft of gas in 24 hr through 22/64-in. choke.

Drills 11th Ellenburger

A new producer has been completed in the Andector pool, Ector County, Texas. Placer Development, Ltd., has reported Coronet Oil Company's 11th Ellenburger well at a depth of 8548 ft. On test the well flowed 949 bbl of 44 deg gravity oil in 24 hr.

Skelly Gets Scurry Well

Scurry County, Texas is the scene of another good producer, drilled by Skelly Oil Company. The company's No. 7 Pairish in Kelly-Snyder field flowed at a rate of 2648 bbl of oil in 24 hr through 1-in. choke, based on an actual flow of 441.4 bbl of oil in 4 hr. Total depth is 6934 ft.

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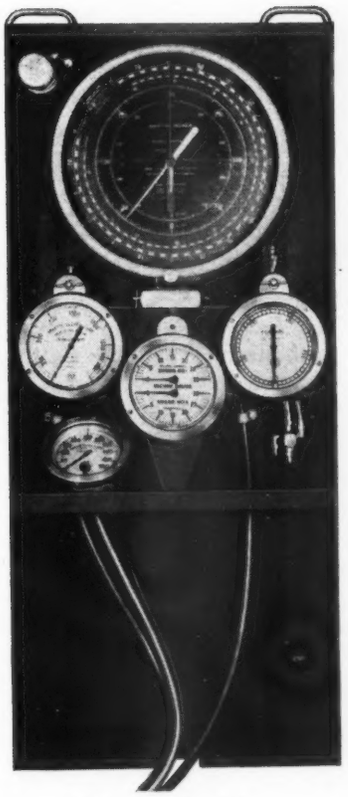
- Increases footage when drilling with small bits
- Indispensable for milling, cutting jobs and DIAMOND CORING



Indicating Gauge can be installed as an individual unit or as an integral part of other Martin-Decker Controls.

For ALL rigs with Chain-Drive Rotaries

The Martin-Decker Hydro-Mech Torque Gauge installed as a rubber-cushioned rotary chain idler provides a remarkably sensitive direct mechanical-hydraulic method of measuring the torque in drill pipe. It is a simple instrument, easy to install and easy for the driller to read and understand. The assembly consists of a load-sensitive element — chain idler, load-responsive cylinder, high-pressure hose, damper and 6-inch "rotate-able" dial indicating gauge

The idler is placed beneath the tight side of the chain between the draw-works and the rotary machine. It consists of a synthetic rubber-tired wheel mounted on a lever arm which actuates a piston in the pressure transmitter. The wheel contacts the under side of the chain, and as the chain raises and lowers under the influence of varying loads, the lever arm moves up or down, decreasing or increasing the pressure in the transmitter. After the installation is completed, the roller height is adjusted by pumping fluid into the system with a small hand pump. Adding fluid to the cylinder raises the roller, deflects the rotary chain, and increases the pressure in the hydraulic system. The amount of rotary chain deflection depends solely on the point on the indicating dial face which the driller wishes to use for torque reference.

Torque built up in the drill string tends to straighten the deflected rotary chain. As torque increases, the rotary chain increases its downward force against the chain idler wheel. The force thus exerted on the wheel develops fluid pressure in the cylinder and that pressure is transmitted through the high-pressure hose to the indicating gauge at the driller's position. In this manner, drill pipe torque above or below the established reference point on the gauge is indicated instantly. The dial gauge is mounted either in the Instrument Panel or nearby in easy view of the driller. A high-pressure hydraulic hose with self-sealing coupling connects the cylinder in the load element to the dial gauge

"Rotate-able" Dial Permits Gauge Setting To Indicate Net-Torque-On-Bottom

The gauge is designed with a "rotate-able" dial, permitting the driller to zero out friction on drill pipe; thus, the gauge indicates net-torque-on-bit This feature is especially valuable in assisting the driller on wells where friction from any cause tends to absorb weight during drilling operations The torque built up by rotation before weight is applied to the bit is measured by the gauge, but is zeroed off by means of rotating the dial to zero, then as weight is applied, the work being done by the bit at the bottom of the hole is instantly reflected by increased readings above the zero reference point on the gauge.

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PAYS FOR ITSELF IN A FEW HOURS . . . in time and equipment savings when milling, washing over, running diamond core heads, directional and deep hole drilling.

•

Adaptable to all rigs with chain-drive rotary tables.

•

The torque gauge that operates on diesels.

•

REMARKABLE SENSITIVITY— Responds to very small changes in torque.

•

Can be set for net-torque-on-bottom with "rotate-able" dial adjustable by rotation through 360° — zeros out hole friction, allowing work load at bit only to be measured.

•

Easy to install and easy to adjust to any chain.

•

Easy to move from well to well.

•

Stabilizes the chain and gives longer chain life.

•

Can be furnished for single- or double-link chain.

•

A SIMPLE INSTRUMENT — Easy to read and easy to understand.

•

Minimizes danger of twist-offs.

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EXPLORATION ACTIVITIES

Gulf and Hunt Have Discovery Near Saline Lake

Gulf Refining and Hunt Oil Company have made a new find in northern Louisiana, La Salle Parish. These companies completed an exploratory well, No. 25 Louisiana Delta Hardwood Lumber Company, Inc., between 5485 and 5490 ft in the Wilcox sand. The well flowed at an indicated daily rate of about 325 bbl of high quality oil, 42 to 45 gravity through a 12/64-in. opening in the pipe.

Although the well is only a mile and a half north of the Saline Lake oil field, this well is called a new discovery because several dry holes have been drilled between the new well and the old field.

Nevada Test Drilling

Continental Oil Company is drilling below 3500 ft at its No. 1 Meridian wildcat in White Pine County, Nevada. Object is Eureka sand around 7500 ft.

The well is a "tight hole", with no information on geology or tests being released at this time.

South Carlton Field

Humble Oil and Refining Company has released information on its No. 1 Marion Wall Davies discovery well in southern Clarke County, Alabama. The well is producing from the Lower Tuscaloosa through perforations at 5419-29 ft. Completion gauge was 80 to 100 bbl per day on pump with gravity of oil 18.2 deg. In addition to the zone from which the well was completed, tests have been completed at 10 other intervals in the well either by drill stem tests from open hole or through perforations after casing was run. The name "South Carlton Field" has been chosen for the field.

New Oil Pool in California

The Goshen Syndicate has opened a new oil pool in Kings County, California, with its Drummond-Unit No. 2. Situated six miles east of the town of Hanford and about 18 miles southeast of the Riverdale field in Fresno County, this is the most easterly production in Kings County. The new well was drilled to a total depth of 5404 ft, with casing cemented at 5389 ft. It flowed 150 bbl of 18.5 gravity oil daily through an 18/64-in. beam.

Kansas Gets 95th Find

C&G Drilling Company opened a new oil pool in Graham County, Kansas recently, making it Kansas' 95th discovery for the year. The new well, No. 1 De Young, has made the maximum 3000 bbl daily on drawdown test, the state conservation division reported. It was tested at 3826-39 ft in Arbuckle lime, and is listed as pool opener of the De Young (Arbuckle) pool, 1½ miles south of Morel field production.

Deep Pool Opened

In Rapides Parish, south Louisiana, Texas Pacific Coal and Oil Company, Fort Worth, Texas, has opened a new deep pool. With completion of its No. 1 Elliott, the well flowed 504 bbl of 39.4 gravity oil daily, with production from 10,698 to 10,713½ ft. The company has staked an east offset to the discovery.

Well Goes Below 12,000 Ft

Shell Oil Company has brought in a new oil field 8 miles south of Baton Rouge, Louisiana by the completion of its No. 1 Vivian Gianelloni. Flowing 454 bbl a day through a ⅛th in. choke the well was drilled to 12,100 ft. Perforations that showed oil sand, however, were 10,876 to 10,890 ft.

Ohio Oil Proves Deep Gas Field in Oklahoma

The Ohio Oil Company has proved a new deep gas field in northeastern Coal County, Oklahoma, at its No. 1 Jones. On the second test the wildcat gaged 4,500,000 cu ft of dry gas a day through a ½-in. choke from Bromide dolomite at 8960 to 9042 ft. Flowing pressure was 2625 psi, and shut-in pressure increased to 4.075 lb in 10 min. The first test was made at 8840 to 9000 ft, when the flow was estimated as high as 5,000,000 ft. Flowing pressure was 2350 lb and shut in pressure 3250 lb.

Pool Opener Brought in

L. B. Stableford's No. 2 Harter has been completed in Stafford County, Kansas as an oil pool opener. The well made its potential, 81 bbl daily, on pump test at 4187 ft total depth, and credited as opening the Harter pool.

Preliminary Surveys Encourage Oil Search in Abu Dhabi

In the Shaikhdom of Abu Dhabi, largest of Trucial Coast Shaikhdoms on the Gulf of Oman, Petroleum Development (Trucial Coast) Ltd. has begun extensive oil search. Favorable reports have been made on a structure at Ras Sadr by postwar seismic and gravity surveys. A protected anchorage for small craft has been developed at Khor Ghanadan, and a 20-mile roadway constructed from the equipment unloading camp to location, where a field camp, power house, and aircraft landing strip were constructed at the edge of the sand dune country.

The southernmost wildcat operation in the Middle East was spudded in last February by the ruler, and the British-built Ideal-100 rig is drilling ahead for maximum core recovery for correlation purposes.

Gulf and Hunt Have New Deep Formation Opened

A new oil and natural gas producing formation has been discovered below the known Fordoche oil field in Pointe Coupee Parish, Louisiana. Sinclair Oil and Gas and The Texas Company drilled a well below the Fordoche at their No. 2 Green. The test was made between a depth of 9066 and 9094 ft and a daily production of 310 bbl of high quality crude oil, 56.9 gravity and 8,250,000 cu ft of natural gas through a 24-64 in. opening in the pipe. Previous production formation for the oil pool was between 8100 and 8300 ft.

Runnels County Pool

G. B. Cree's No. 1 O. C. Sykes in Runnels County, Texas has been completed for a daily natural flow of 330 bbl of gravity oil. This opens a new pool in Runnels county. The well was drilled to 3874-3894 ft.

Nebraska Discovery Made

A new Nebraska well has been discovered by Deep Rock Oil Corporation and Frontier Refining Company in Cheyenne County. The new well. No. 1 Siemers, is a possible extension of the Huntsman oil field, and if so will extend the well one to three-quarters of a mile. Test of the sand between 4815 and 4830 ft recovered 4000 ft of oil and 420 ft of salt water.

Measure any other pressure control equipment against the advantages of the

SHAFFER COMBINATION ROTATING BLOWOUT PREVENTER AND STRIPPER

There's only one way to fully appreciate the unequalled pressure protection you get in the Shaffer Combination Rotating Blowout Preventer and Stripper . . . that's to measure—point-by-point—*any other* equipment on the market against the unique operating features incorporated into this unusually effective unit. For example . . .

MEASURE FOOL-PROOF DEPENDABILITY!

The Shaffer Combination Rotating Blowout Preventer and Stripper maintains its leak-proof seal *continuously* while pipe is in the hole. There is nothing to *operate*, nothing to *remember*, nothing to *forget*, when sudden pressure emergencies occur. The unit is *always* sealed off around the drill string, ready for instant protection against pressure blowouts!

MEASURE ALL-AROUND ADAPTABILITY!

The Stripper Rubber seals off around *any shape or diameter* in the drill string (excepting such abnormally large diameters as the bit and reamer). Automatic expansion and contraction accommodates any type of kelly—square, hexagonal or octagonal—as well as couplings, tool joints, subs, drill collars and pipe, whether flush, coupled or upset. *No special equipment or special pipe is needed with this unit!*

MEASURE TROUBLE-FREE OPERATION!

Since the Stripper Rubber rotates *with* the kelly—not around it—there is virtually no wear on the rubber. Patented steel reinforcing latches provide an expandable steel barrier that prevents extrusion of the Stripper Rubber either by high pressures or by pulling large diameters through it—yet maximum elasticity of the rubber is maintained. In addition, the bearing assembly upon which the unit rotates has separate thrust and radial bearings to withstand the severe loads occasioned by modern drilling practices . . . and the bearings are lifetime prepacked with heat-resisting lubricant. Maintenance is negligible!

MEASURE OPERATING SIMPLICITY!

When the drill string is in the hole, adjustment to different diameters and shapes in the string is *completely automatic*—no manual operations are necessary. When running large tools such as bits or reamers through the unit, simply pull a spring latch, rotate the bonnet 1/6 turn and the entire internal mechanism as a unit can be withdrawn to permit removal of the tools. Simply reverse the operation when going back into the hole.

MEASURE SPACE-SAVING COMPACTNESS!

The Shaffer Combination Rotating Blowout Preventer and Stripper is so engineered that vertical height in the drilling riser is kept at a minimum. It can be installed even under the most difficult space limitations. Moreover, flow connections built directly into the body eliminate need for spools or other equipment for overflow connections.

These and other unique advantages of the Shaffer Combination Rotating Blowout Preventer and Stripper—plus the *quality* that is built into every part—make it the most *efficient*, most *versatile*, most *practical* pressure control unit yet developed. Investigate and compare it with *anything* else on the market!

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New Find in Oldenburg

Best producing well to date in the Oldenburg field of Franklin County, Mississippi has been completed by William Helis, independent operator of New Orleans, Louisiana. The well flowed 324 bbl of 39.2 gravity oil daily through 12/64-in. choke. Production is being obtained from perforations in the Tuscaloosa zone at 10,534-46 ft. Tubing pressure was 1475 lb, shut in tubing pressure, 1600 lb, and gas-oil ratio was 1224 to one. Total depth of the hole was 10,649 ft and has 7-in. production casing cemented to total depth.

Proves 2nd Oil Zone

A second zone for production has been proved at Danciger Oil and Refining's No. 1 Bryan Goldsby on the east side of the Southwest Goldsby pool of McClain County, Oklahoma. Perforating the McLish at 9820-38 ft with 144 holes, the well was flowing 14 bbl of oil per hour through ½-in. choke, with the crude testing 38 gravity. The deep well, previously tested at 10,156-178 ft in the Joins sand, flowed at the rate of 15.6 bbl of oil per hour through a ½-in. choke. Total depth is 10,206 ft.

Emrick Montana Well

E. B. Emrick's Lederer 1, a mile and a half east of the nearest production in Pondera field, in Montana has been completed as a producer. The new well swabbed 100 bbl of oil, no water, after acidizing with 10,000 gal. The well was drilled 3 ft into Madison lime topped at 1937 ft.

Rig in Assam Jungle Is Making Deep Test

The wildcat test being drilled by The Assam Oil Company, Ltd. at Barsilla in the Assam jungle is below 5300 ft at last report. The same rig last year drilled a test in the Tiru hills, which proved to be dry. It is expected that settlement of the Bengal-Assam frontier dispute will stimulate activity to supplement the production at Dibgoi.

Attock Oil Company has been producing oil for more than 30 years in the West Punjab in northern Pakistan. Last year Burmah Oil Company (Pakistan Concessions) Ltd. drilled a deep dry hole at Lakhra in the Sind desert. A successful well was drilled in the Chakwal area a year ago.

McDonald Anticline, California Has New Production

Glen Ferguson and I. W. Bosworth of Bakersfield, California have completed Layman No. 2 for a new discovery on the McDonald Anticline, in the San Joaquin Valley, California. Present production is 240 bbl of 29.8 gravity oil and 25,000 cu ft of gas daily through a 16/64-in. orifice. Open to production is 80 ft of Buttonbed sand topped at 1977 ft. Total depth is 2057 ft.

Florida Test Deepened

The No. 1 McDavid Veneer Company, wildcat test in Escamba County, Florida, is being drilled below 5345 ft at latest report. John S. Nielson and W. E. Walker are operators.

Belgian Company Finds New Canadian Production

Viking oil has been discovered 45 miles east of Stettler by Canadiana Fina, the Canadian unit of Petrofina of Belgium at its Fina Bulwark Province No. 1. Situated on land belonging to Sun Oil, Phillips Petroleum, Husky Oil and Refining Companies, the well got 2 rises of water-free oil, 70 ft and 130 ft from a 10-ft section of the sand around 2950 ft. It was taken down to the Dévonian to 4100 ft, but plugged back. Casing is now being run. The oil show is the third in the province for the Viking sand.

Olson Well in Oklahoma

Olson Drilling Company has a new well in Pottawatomie County, Oklahoma, its No. 1-A Moore, drilled to a total depth of 3713 ft. The new well began producing 41 gravity oil when drilled in and made 44 bbl of oil naturally the first 24 hr. It was then given a 10-qt shot and production increased to 85 bbl the next 20 hr. When the operator began to swab and clean out, the well kicked off after swabbing 35 bbl of oil and flowed 79 bbl during the remainder of the 24-hr period for a total output of 144 bbl in the 24 hr.

Ashland Drills Outpost To Northeast Edmond Pool

Ashland Oil and Refining Company is adding a discovery well at an outpost to the Northeast Edmond pool in Oklahoma County, Oklahoma at the company's No. 1 Shannon. Nearly a mile northwest of production in the Northeast Edmond field, the wildcat was taken to 5990 ft after plug was drilled from casing set at 5971 ft on the sand. Swabbed in, the well, which is producing from the Bartlesville sand, flowed 137 bbl of oil in 12 hr. through ½-in. choke.

Plan Wildcat Venture West of Bakersfield

Campbell-Shell and Collins, a new partnership of Alex N. Campbell, Joseph C. Shell, and C. E. Collins, have staked location for a wildcat venture 1 mile west of Bakersfield, California. The test is to be known as Stockdale-K.C.L. No. 1. This site falls about ½ mile south of the nearest production in the Fruitvale oil field.

Objective will be the Kernco series of sands, which in this area are expected at about 4400 ft. The play is based on the hope of finding an extension to the main Fruitvale fault, which is thought to run north and south along the east line of Section 3.

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International developments of the past several weeks have brought up the subject of shortages and undoubtedly, the oil industry will feel the effects immediately.

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This situation could be unbalanced, however, by unnecessary purchasing and scare buying and we therefore, urge all of our customers to place their orders with us for equipment when and as needed, rather than placing orders on a "future needs" basis.

We believe it is a direct and absolute responsibility of management to do everything in its power to head off the growing inflation and to this end, we seek your cooperation.

We wish to assure you that we very much appreciate your business and we will continue to produce the finest equipment in the field.

Sincerely,

John Maher

running tour with men in the industry

Fred Sherer has been appointed field superintendent of Bakersfield and Riverdale, announces LeeBoyd Construction Company, replacing **Gene Lee** who has resigned to accept an engineering position with another firm. Sherer is experienced in oilfield construction work, having had 15 years supervisory work with Union Oil Company of California in the service and construction departments; service with the Seabees in the Pacific, and subsequent supervisory experience with Key Contractors, Inc., and Braun Company. **L. F. "Moon" Mullen** will remain as general foreman at Riverdale.

William N. Cones has been elected vice president in charge of production and exploration of the Panhandle Producing and Refining Company, Mercantile Securities Building, Dallas, Texas. The announcement was made by John V. Boyce, president of the company, after the meeting of the board of directors in New York.

F. W. Fritz Mueller, formerly with Skelly and Rutherford, is now in charge of land and geology for Heep Oil Corporation, Brown Building, Austin, Texas.

Dr. Alexander Rosenberg, head of the land and lease division of the producing department, Socony-Vacuum Oil Company, Inc., New York, died recently. A native of Poland, Dr. Rosenberg began in 1922 with a Socony-Vacuum subsidiary in Poland in charge of leases. Several years later he was placed in charge of marketing refined petroleum products in Poland. He came to this country in 1940 as a member of Socony-Vacuum's headquarters staff and was advanced to head of the land and lease department several years ago. He studied at the University of Vienna and the University of Lemberg, Poland, receiving a doctor of laws degree from the latter.

James C. Condon has been appointed geologist and exploration manager of the new Imperial Petroleum Company, which is headed by **Robert L. Williams.** Condon formerly was employed by Shell Oil Company and Anderson-Prichard Oil.

W. E. Brown, T. J. Weigel, and **M. H. Shaw,** Shell Oil Company, have been appointed to the newly created land department, devoting their time to gathering land information.

C. C. Gandaubert

E. V. Watts

C. C. Gandaubert, formerly superintendent of the production department's southern division, General Petroleum Corporation, has been promoted to the post of general superintendent. **E. V. Watts,** production superintendent of the southern division, advances to southern division superintendent. **A. W. Titus,** senior production foreman of the Beaches area, replaces Watts as production superintendent of the southern division. **H. C. Carrothers,** production foreman, becomes senior production foreman, replacing Titus at General Petroleum's Long Beach field office.

In his new post Gandaubert will have general supervision of the three California divisions of General Petroleum's production department, headquarters of which are in Vernon, Ventura, and Taft. He joined the company in 1920. Watts received his engineering degree at the California Institute of Technology in 1936 and joined General Petroleum 3 months later as a roustabout in the Lost Hills field. He has been production superintendent of the southern division since 1949. Titus joined General Petroleum in 1924 and has been senior production foreman since 1948. Carrothers, who has been with General Petroleum since 1923, has served as a production foreman in the Wilmington area since 1942.

Gerald W. Pike, formerly with Derby Oil Company, was recently appointed head of the land and geological department of Pickrell Drilling at Wichita, Kansas.

B. A. Barnes, formerly petroleum engineer for Magnolia Petroleum Company at Salem, Illinois, has been transferred to the company's general offices in Dallas, Texas.

Dr. Peter Dehlinger, geophysicist, has been appointed to the staff of Battelle Institute, Columbus, Ohio, where he will be engaged in research for the oil well drilling industry. Dehlinger was formerly associated with the Shell Oil Company at Los Angeles as a seismologist. He is a graduate of the University of Michigan and received his MS and PhD degrees in geophysics from the California Institute of Technology.

James W. McColl was appointed assistant to **H. Ben Cox,** superintendent of the land department, Cities Service Oil Company (Delaware). McColl, who has been a member of the legal department of Cities Service since 1946, was formerly employed as a land man in the Illinois oil fields and worked in the Bartlesville office of the land department before he was called to war service in 1941. He was graduated from the law school of the University of Oklahoma with an LLB degree and was admitted to the Oklahoma bar the same year.

A. G. Lawver, was named supervisor of administration; **Ed. E. Owen,** supervisor of titles; **Burton Corn,** supervisor of contracts, and **R. B. Geisel,** supervisor of gas acreage in the Bartlesville office of the land department. **W. C. Dunlap,** former supervisor of contracts resigned to re-enter business at Houston, Texas.

Robert M. Swesnik, formerly division exploration manager in south Oklahoma for Anderson-Pritchard Oil Corporation, has become subsurface geologist for General American Oil Company of Texas. His headquarters are now in Dallas, Texas. A graduate of Oklahoma University, Swesink has been with Apco for about 5 years.

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Running Tour

Guy R. (Pete) Brainard, Jr., has recently become production manager for the Niles Oil Company with headquarters in the Mercantile Securities Building in Dallas, Texas. He had been employed by Seaboard Oil Company in Dallas as assistant production manager for the past two years.

G. R. Brainard

Brainard is a native of New Mexico and was graduated from Louisiana State University in 1932 with a degree in petroleum engineering. He has had wide experience in drilling and production with various companies, including Ohio Oil in the East Texas field; Shell Oil Company in East Texas, the Gulf Coast, West Texas, and New Mexico.

Ray Fickel, geologist for Sinclair Oil and Gas Company at Amarillo, Texas has been transferred to Houston. **Don Gibson** succeeds him in Amarillo, and **Corwin Smith** is transferring to Amarillo from Houston to replace Gibson.

Willis W. Hardy, Socony-Vacuum Oil Company, Inc., chief geophysicist since 1939, has been appointed assistant chief of the company's exploration division. A graduate of the University of Chicago, Hardy joined Socony-Vacuum in 1938.

Frederick H. Callaway, formerly senior petroleum engineer, Stanolind Oil and Gas Company, has been appointed reservoir engineering supervisor in the producing department. Callaway received his bachelors degree in petroleum engineering from the University of Texas in 1946, and joined Stanolind in September of the same year. **William H. Wheatley** has been promoted from inspection supervisor to senior mechanical engineer in the manufacturing department. Wheatley received his bachelors degree in petroleum engineering in 1939 from the University of Oklahoma. He joined Stanolind in 1946.

R. E. (Red) Golemon, for twelve years with the Houston Oil Field Material Company, in charge of the fishing tool division, has become associated with M. J. Delaney Company of Dallas, Texas. In his new post he will be in charge of all drilling operations and will make his headquarters in Dallas.

John T. Hollingsworth has been named assistant general production superintendent of the Signal Oil and Gas Company to succeed the late **Harry C. Meyer.** He will make his headquarters in Los Angeles and report directly to **Richard H. Smith,** Signal's general production superintendent. Until this advancement, Hollingsworth has been superintendent for the Santa Maria area for Signal. **Willis E. McCullough** will become superintendent in the Santa Maria area succeeding Hollingsworth. Until this time, McCullough has been production foreman on Signal's Santa Maria operations.

George L. Ellis has been named division geophysical coordinator for the North Texas-New Mexico division of Stanolind Oil and Gas Company. Ellis, a senior geologist here since December 1948, joined Stanolind in July 1945. He received his bachelors degree in petroleum and mining geology from Pennsylvania State College in 1917.

W. O. Keller and **L. F. Peterson,** formerly employed as engineers by Stanolind Oil and Gas Company have formed the Keller and Patterson firm. Situated in Midland, Texas, the firm will be engaged in petroleum and geological engineering, property appraisals, reserve estimates, and reservoir analysis.

Floyd O. Brett, division production superintendent for Sinclair Oil and Gas Company at Fort Worth, Texas for the past 10 months, has been named assistant general superintendent with headquarters in Tulsa, Oklahoma. He joined Sinclair in 1929 as a gas tester, and by 1942 was made assistant division superintendent.

Walter T. Crandall, formerly assistant division superintendent in Midland, Texas will succeed Brett at Fort Worth. He also joined Sinclair in 1929. **Joseph B. Kennedy, Jr.,** division engineer at Tulsa will replace Crandall at Midland.

Howard D. Henderson, assistant manager of land and exploration for Sohio Petroleum Company, has been promoted to manager and will work with **George S. Buchanan,** vice president of the department.

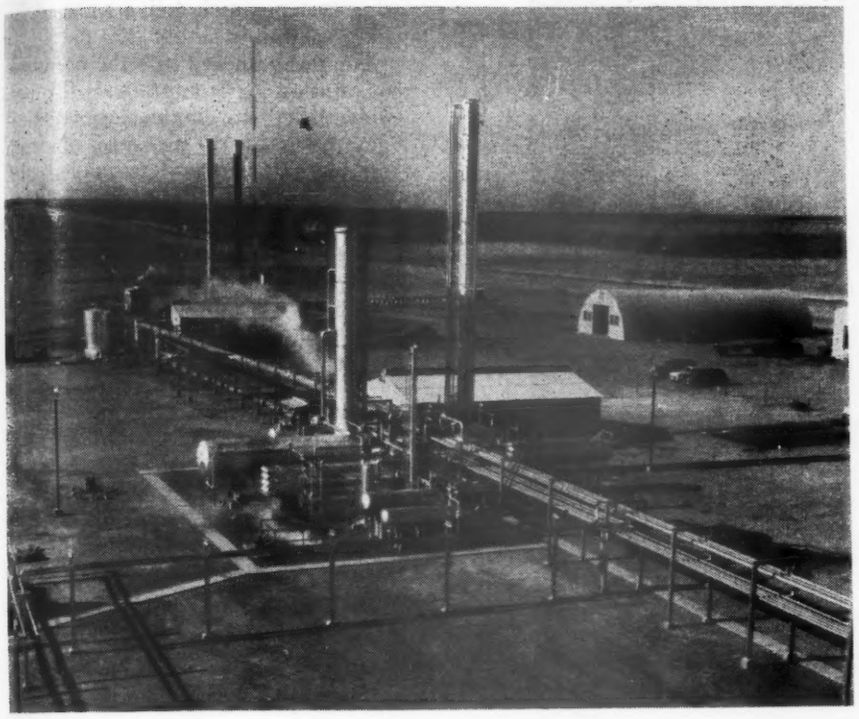
Sam A. Garfield and **M. Dunenberg** have formed the Garden Drilling Company. Their new offices are in Evansville, Indiana.

J. F. Jeansonne, district petroleum engineer, Humble Oil and Refining Company, has been transferred from the Mallalieu district, Louisiana division, to the Odessa district, West Texas division. **E. T. Mace,** toolpusher, transferred from the Wasson district, West Texas division, to the Mallalieu district. **Fred B. VanShoubroveк,** toolpusher, transferred from the Louisiana division to the McCamey district, West Texas division. **W. W. Holland,** toolpusher, transferred from the Eucutta district, Louisiana division, to the Winters district, North Texas division.

W. L. Horner has been named chief petroleum engineer for Sunray Oil Corporation's production department and will head all engineering activity in its Mid-Continent division. Horner was chief production engineer for the former Barnsdall Oil Company, now merged into Sunray, and the new Sunray production engineering section combines the engineering personnel of both companies into one department under Horner's direction. He is chairman of the recently organized Scurry County (Texas) area engineering committee in which more than 50 producing companies are actively participating.

J. F. Adkisson, Jr., has been designated supervisor of the department and is engineer in charge of the water flood section. **George P. Alden** is water flood engineer. **Dr. Charles W. Ziemer** is to be Sunray's supervisor of reservoir engineering. In the reservoir engineering department, **R. H. Parked** and **Walter Kellogg** are engineers; **Don W. Roark,** laboratory technician, and **John R. Morris** and **Doris Davie,** draftsmen. **L. B. Jeffers** has been named proration engineer and **Burns H. Errebo** is engineer in this department. Supervisor of Sunray's production department drafting section is **Fred W. Boethin,** and **Glenn Fielding, John Barton, Koli Amini, Billie Dees,** and **Betty Freeman** are draftsmen in the section.

Staff engineers in the production department are **R. K. Waddell,** geological engineer; **V. M. Williams,** drilling mud engineer; **W. L. Hagan,** mechanical engineer; and **W. P. Parker,** salt water disposal engineer. **Donald L. Moore,** junior engineer and **Lester Martin** are in charge of the engineering records. **Hazel Roden** is secretary to Horner, and **Margaret Pease,** and **Julia Dean** are stenographers in the department.



Colorado Interstate Gas Company's gasoline plant looking toward west. Boiler house is in background.

Gasoline Plant Improves Pipe Line Efficiency

HAROLD F. DAWE* and A. F. SMITH*

THE Colorado Interstate Gas Company completed a new natural gasoline plant to recover hydrocarbons that were condensing in the Lakin-Denver pipe line.

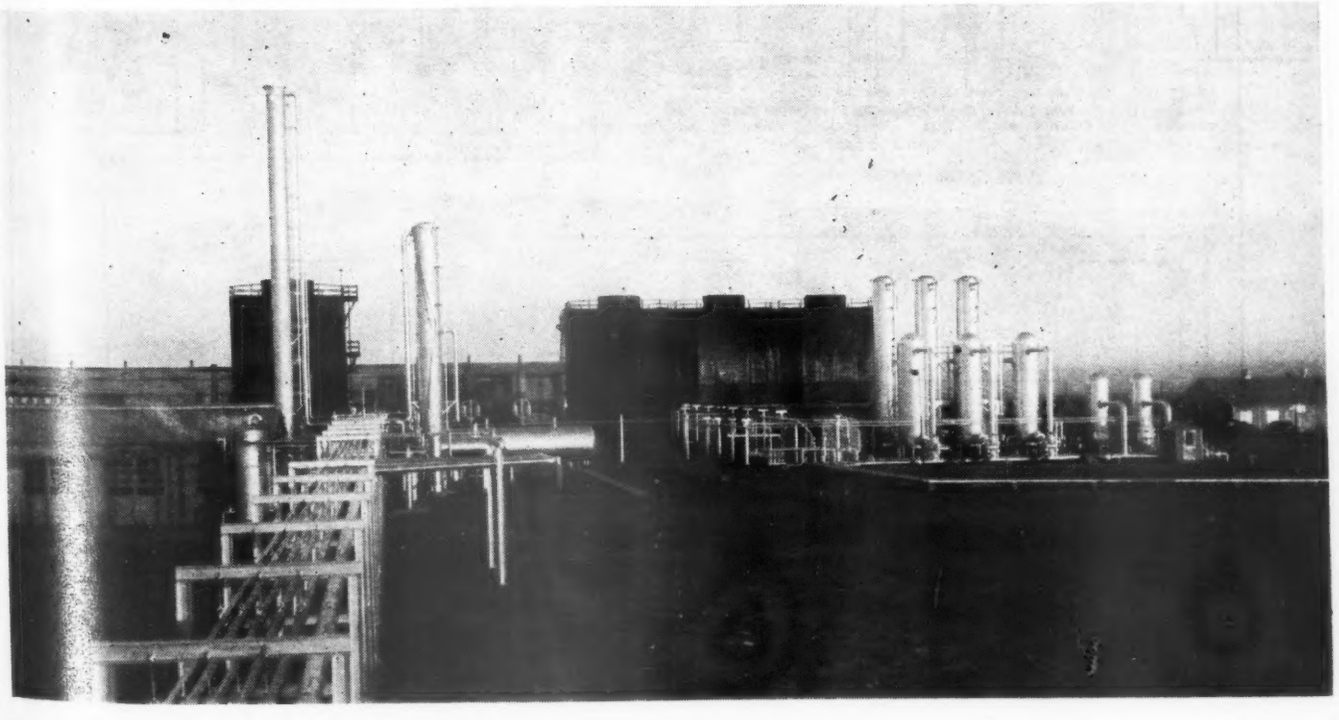
The plant is situated just west of the town of Lakin, Kansas on U. S. Highway 40, on the same site of the 14,400-hp main line compressor station.

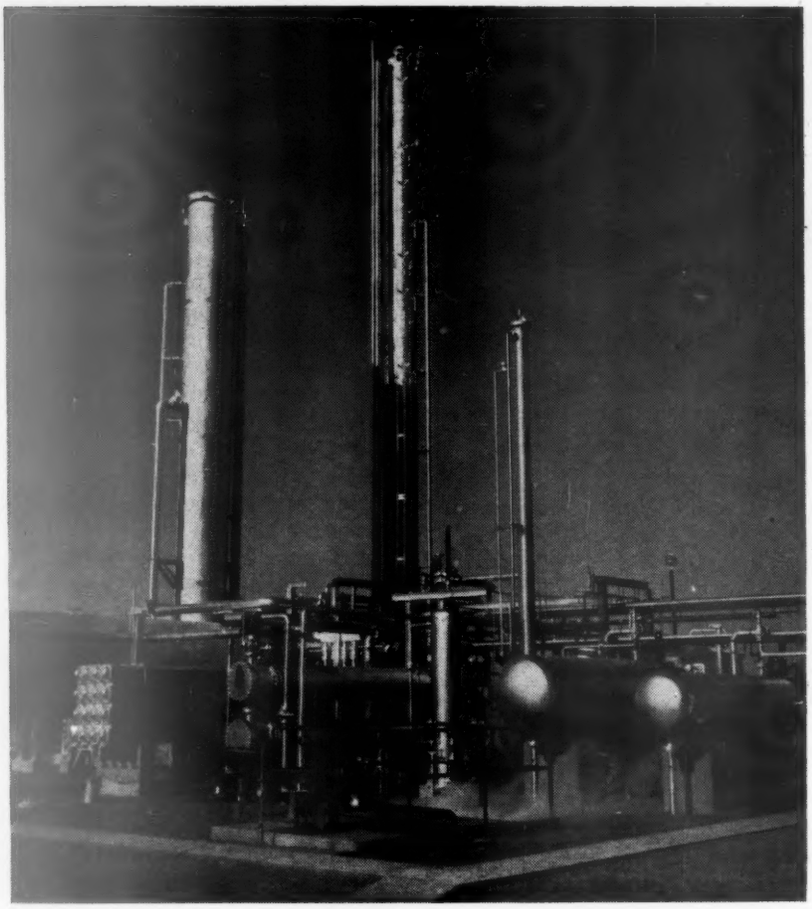
During the winter of 1948-49 it became increasingly evident that hydrocarbon liquids were condensing out in the 20-in. main line from Lakin to Denver and would seriously hamper the transmission capacity unless they were removed. Several main line drips had been installed and it became necessary to empty these several times each day. Faced with this problem and with a large capacity increase required for the winter of 1949-50, the company decided to install a natural gasoline plant at the Lakin end of the main 20-in. line.

The gas production for the pipe line comes from the Kansas Hugoton gas field and is obtained from some 210 wells. These are connected into a vast gathering system that feeds into the suction side of the Lakin compressor station. No hydrocarbons in any quantity have been produced in the gath-

*The Stearns-Roger Manufacturing Co.

View of plant looking east showing absorbers and dehydration contactors in background.



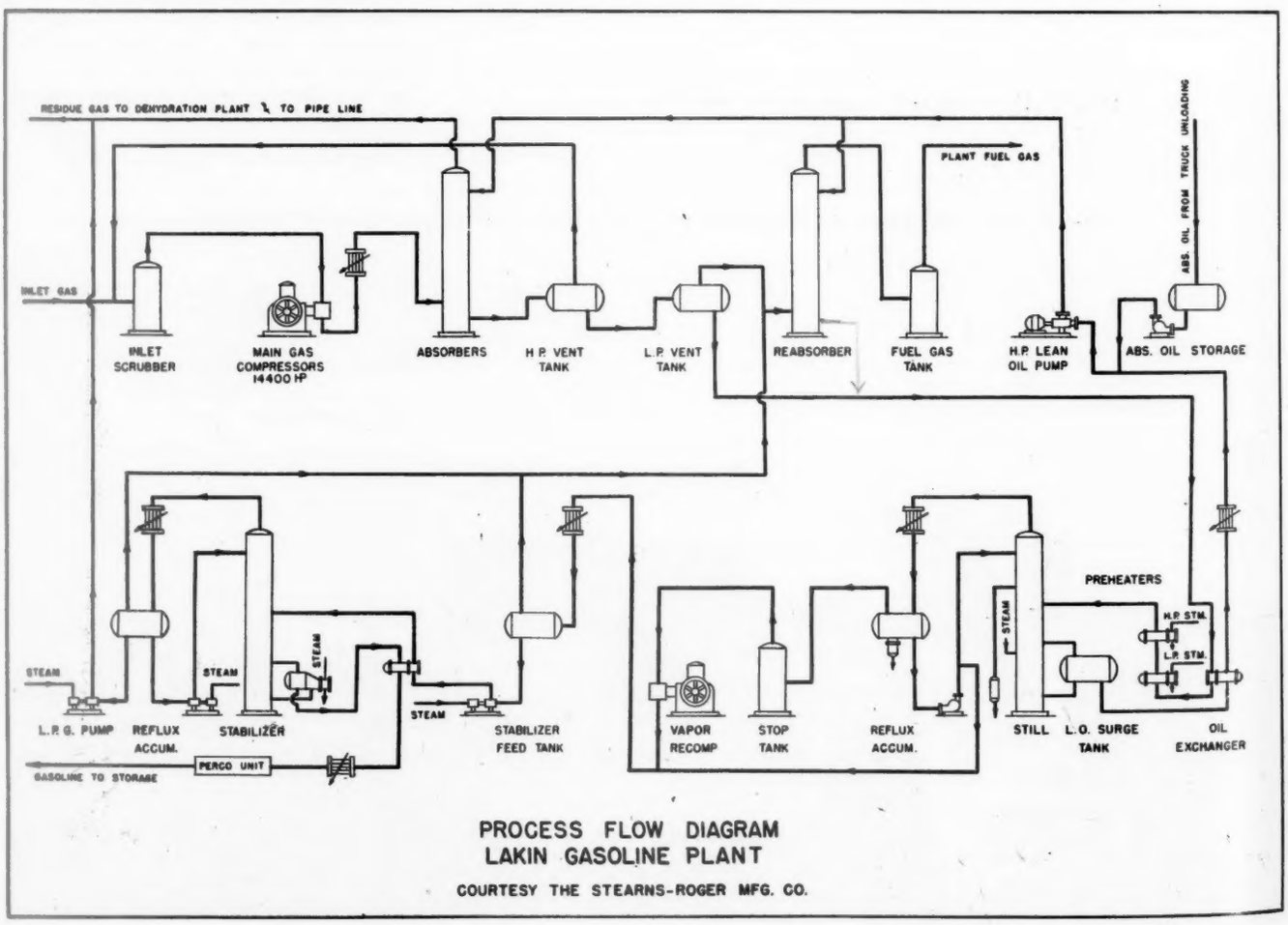


Operating area—gasoline still, stabilizer, and reabsorber.

ering system which delivers gas to the Lakin suction at about 250 psig.

The gas gathered into the compressor station is compressed through twelve 1200 hp single stage vertical compressors to a pressure of from 750 to 900 psig and is cooled and passed through a dry desiccant type dehydration plant to reduce the dew point at Denver to approximately 25 F. It was evident that the condensation occurring in the pipe line was due to the combination of reduction in pressure and temperature as the gas passed through the pipe line. It was decided to place the gasoline recovery plant on the compressor station discharge side and just ahead of the dehydration plant.

Due to contract requirements, the gas must contain a minimum of 968 Btu per standard cubic foot. In order to maintain this value it was necessary to make a series of experimental tests to determine the composition of the gas and to what extent refrigeration would be required to protect the line against condensation at 25 F. Estimates based on these tests were prepared to determine the cost of investment required for both refrigeration and absorption type plants. Production estimates were greatly in favor of the absorption type plant and such an installation was decided upon. Al-



PROCESS FLOW DIAGRAM
LAKIN GASOLINE PLANT

COURTESY THE STEARNS-ROGER MFG. CO.

though the nitrogen content of the gas is approximately 16½ per cent it was not deemed economical to remove that component for the present and the absorption plant was chosen because of the higher production and greater flexibility. An incidental consideration was that the absorption plant would also remove steam cylinder oil which was used in lubricating the compressor cylinders and which appeared in some amount in the dehydration plant.

The absorption plant was designed to remove all the hexanes plus considerable pentanes, some butane and lighter according to the tabulation shown. The LPG removed, relatively small quantity, and is being returned to the line to maintain the Btu value.

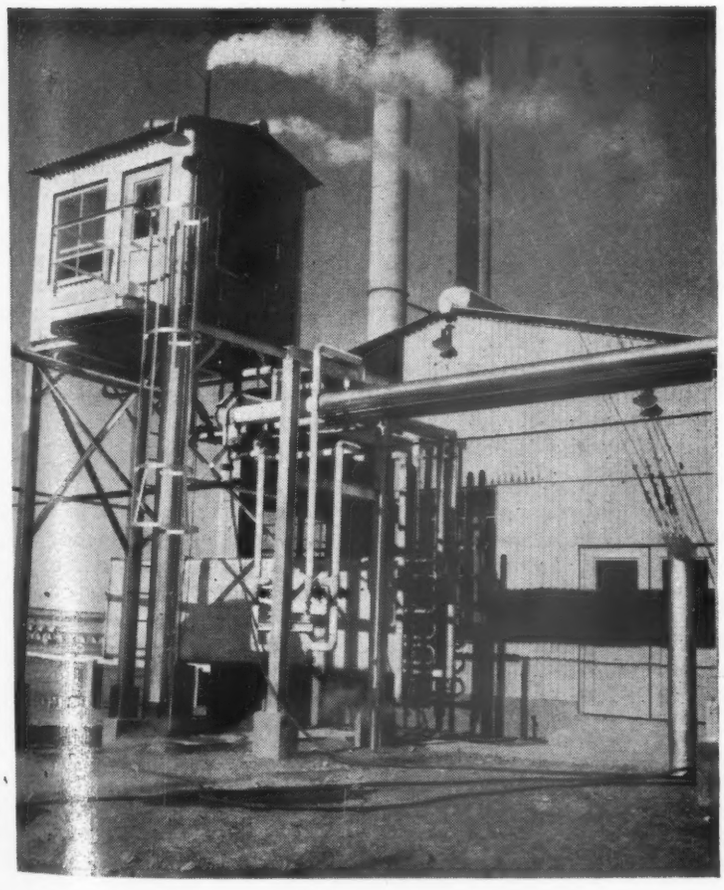
The battery of three absorbers each 72-in. diameter and 43 ft net shell are designed to operate at 945 psig with a maximum flow of 215 MMCFD. The circulation rate for lean oil is 40 GPM per absorber. The lean oil is circulated using 3 in. by 5 in. stroke triplex plunger pumps operated by 100 hp explosion-proof electric motors through herringbone gear reducers. The residue gas is sent to the dehydration plant inlet scrubbers, then passes into the dehydration contractors and into the main pipe line.

The rich oil from the absorbers is reduced in pressure to just above compressor suction conditions of 200-250 psig in the high pressure rich oil vent tank, which is a horizontal vessel 36 in. in diameter by 12 ft net shell, having design working pressure of 400 psig. The lighter hydrocarbons are then returned to the compressor plant suction. The partially flashed rich oil then flows to the 48-in. diameter by 12 ft 0 in. horizontal low pressure flash tank that operates at a pressure of approximately 115 psig with design working pressure of 150 psig. The gas flashed in this tank is sent to a reabsorber 12 in. in diameter by 28 ft net shell where the gasoline components are absorbed in the lean oil. The rich oil from the reabsorber is mixed with the rich oil stream from the low pressure flash tank. Residue gas from the reabsorber goes to the vertical 24 in. diameter by 8 ft net shell fuel gas stop tank where any remaining liquid is separated and the gas enters the fuel gas system at 40 psig to be used as fuel in the steam boiler section of the plant.

The main stream of rich oil from the low pressure flash tank and the reabsorber is preheated through exchange with hot lean oil from the gasoline still and low and high pressure steam to a temperature of approximately 370 F and then enters as the stream feed to the gasoline still. The absorbed components are stripped from the rich oil in the still by use of stripping steam.

The overhead vapor from the still is condensed in atmospheric sections in an induced draft cooling tower and the condensed liquid is pumped into the horizontal 60 in. diameter by 20 ft gasoline stabilizer feed tank. The feed stream to the stabilizer from this vessel is preheated by exchange with the bottom gasoline from the stabilizer to raise its temperature to about 175 F. Gasoline of the desired RVP is produced in the 30 in. by 70 ft net shell stabilizer through control of the stabilizer reboiler temperature. The excess liquid LPG from the stabilizer overhead is returned into the residue gas line downstream from the main absorbers. Vapors from the stabilizer accumulator are usually returned to the reabsorber, but may be returned to the compressor plant suction.

A single 8 in. by 9 in. stroke double acting cylinder compressor driven by a 40 hp explosion-proof electric motor is used to compress the vapor from the horizontal 40 in. diameter by 10 ft net shell still reflux accumulator after the vapor recompressor stop tank and mix this with the excess top product from the still before the excess top product from the still has been condensed and sent to the stabilizer feed tank. This is done to cause a portion of the heavier hydrocarbons in the gas to be condensed in the top product. This ultimately results in reducing the amount of absorption oil



At left are deaerator heater building and boiler-feedwater heat exchangers. Below is gasoline loading rack.

required for the low pressure reabsorber as the vapor from the feed tank goes directly to the reabsorber.

The bottom product from the gasoline still of the desired RVP is cooled and sent to the battery of seven 10 ft diam by 50 ft net shell horizontal gasoline pressure storage tanks designed for 30 psig working pressure. The tanks are protected from over pressure by pressure relief valves.

Just ahead of the gasoline tanks the gasoline is sweetened in a Perco treating unit.

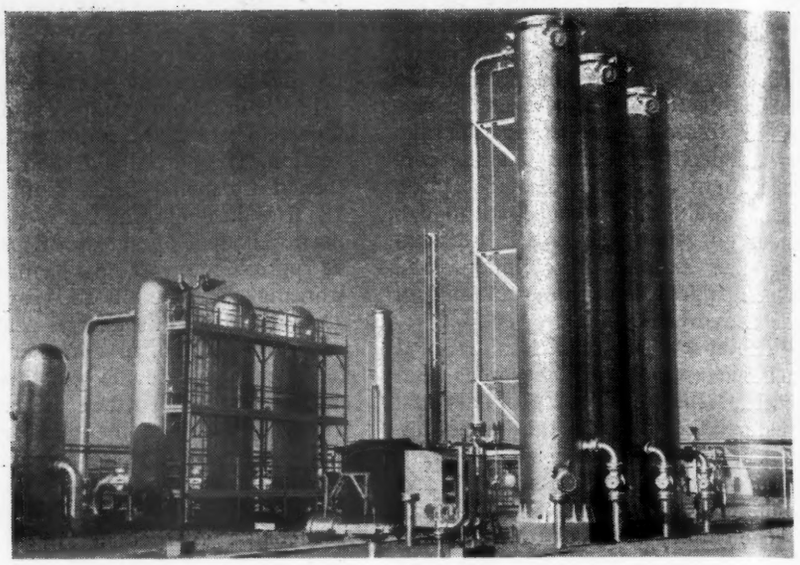
The gasoline production is shipped from the plant by means of tank cars. There are two shipping pumps 150 gpm driven by 15 hp explosion-proof electric motors installed in a separate 10 ft wide by 12 ft long by 8 ft high section steel building. These pumps move the production through 1¼ miles of 4 in. pipe line to a 14-car double loading rack located on the main line of the Santa Fe railroad. A truck loading rack has also been installed at the same location to take care of occasional demands for gasoline by commercial tank trucks.

The steam demands for the plant are approximately 12,000 lb per hour. The required steam is produced in two 150-hp oil field boilers, one acting as spare, at a 350 psig pressure.

A vertical 48 in. diameter by 12 ft high cone roof oil skimmer tank removes the oil from the steam condensate and the substantially oil free condensate is returned to the 10 ft diam by 15 ft high vertical boiler feed water tank. The boiler water is deaerated in a vertical deaerator before entering into the boilers and it is also preheated by exchange with the returning condensate from the still preheater. The boiler feed water pumps are 10 in. by 6 in. by 12 in. simplex double acting steam driven pumps.

Steam from the plant is also used to provide heat for a regeneration gas stream booster heater for gas in the dehydration plant. The dehydration plant was increased in capacity using the existing direct fired heater. The steam booster provides the extra capacity needed in conjunction with the increased capacity. The steam driven pumps are stabilizer feed pump, reflux, and common spare, LPG pumps, boiler feed. Steam under reduced pressure is utilized to steam trace liquid level controls, gauge glasses, flow meter pots, and to heat the various buildings. The water used in steam production is given special treatment.

The gasoline plant is laid out to the west side of the compressor plant and on a slight slope. Advantage is taken of this grade to insure that in the event of breakage of lines or tankage the products will drain away from the main plant.



Dehydration contact towers, left, and absorber battery.

It was considered more economical and to provide much more satisfactory operation and maintenance to electrify as many of the prime movers as possible. The then existing electric generating capacity would not meet the demand of the additional load of the gasoline plant and an additional 282 KW gas engine driven generator was installed in the auxiliary building. This additional unit provides ample generating and makes available spare capacity for both the gasoline and compressor plants. The existing auxiliary building was extended to house the new unit.

Additional cooling water to satisfy the demand of the gasoline plant has been made available through a new 1-cell 4-bay induced draft cooling tower. The tower has one fan driven by a 20-hp explosion proof electric motor and 1200 gpm of cooling water is circulated by two 25-hp vertical enclosed fan-cooled electric motor driven pumps, one acting as spare.

The boilers, pumps and recompressors and control panels, are housed in custom-built steel frame buildings covered with corrugated asbestos cement board, the buildings are adequately ventilated through full ridge type vents. The boiler building is 30 ft long by 40 ft wide by 14 ft high, the pump building is 32 ft wide by 48 ft long by 10 ft high.

A steel frame, corrugated and galvanized sheet iron building 40 ft long by 100 ft wide by 10 ft high is used as a combination laboratory and warehouse. Originally the building was purchased to be used as a temporary warehouse and plans were made to enlarge the existing compressor plant laboratory to serve both the compressor and the gasoline plants. This later proved impracticable and a 20-ft section of the steel building was set aside for use as a laboratory for both plants. This section has been completely insulated and finished on the interior and fitted out as a very complete and air-conditioned laboratory. The equipment includes Junkers calorimeter, recording calorimeter, dew point recorder, RVP bath and testing equipment, supercompressibility test apparatus, dew point testers, ASTM distillation apparatus and other related equipment.

It was considered necessary to provide a large volume of water under pressure for fire protection. To serve this function a 250 gpm at 100 lb pressure centrifugal pump driven by 20-hp electric motor was installed in the auxiliary building.

The gasoline plant has produced approximately 25,000 gal of 26 rvp gasoline per day on the peak days since going into operation. The higher design peak days have not been experienced this winter. The flow conditions have resulted in better than expected gasoline production consistent with the maintained Btu value of the gas. The line drips have been completely dry for some time.

The plant was designed and constructed by the Stearns-Roger Manufacturing Company in collaboration with the Colorado Interstate Gas Company. * * *

MODERN PIPE WELDING PRACTICES

F. C. FANTZ*

PART 2

Facings for Flanged Joints

Flange facings may be divided into two general classes: First, those which are applied directly to the flange, regardless of whether the flange be attached by threaded or welded means; and second, those which are applied to the lapped ends of pipe and used with standard van stone type flanges acting solely as clamping members. Note that in either case, the facings may be used in opposition; those applied to pipe laps are identical in dimensions with those machined directly on the flange or applied to valves and other equipment. Flange joints may therefore compare an integral flange on a valve, and a lapped joint on the adjacent pipe; or a butt-welding flange on one section of pipe may be set against a lapped joint on the continuing section of pipe.

Flange faces may be further divided in accordance with the means used to seal the joint. In this regard, the most commonly used method involves the use of a gasket that is compressed between the two abutting faces. The primary purpose of such a gasket is to fill up the imperfections left on the joint faces in machining. Usually the gasket is of fairly soft material, such as asbestos or rubber. These have very little strength in themselves and flange faces are customarily machined with a low serration, in order to grip the gasket and prevent pressure in the pipe line from blowing out the joint. When the gasket is fabricated from a tougher material, such as iron or soft steel, the serrations will not be completely buried in the gasket, thus reducing the total gasket bearing-surface and consequently increasing the unit bearing pressure.

Types of flange facings are shown in Fig. 10. Those which utilize flat gaskets are shown in details A, B, and C of this photograph. The raised-face flange shown in detail A is the most commonly employed and is entirely serviceable for low and medium-pressure work. This is the type of facing normally found on flanges drawn from warehouse stock.

Detail B shows a large male-and-female joint. The male section is identical with the ¼-in. raised face illustrated in detail A. The female section is provided with an annular ring for the dual purpose of centering the flange and preventing gasket blow-out.

In detail C, we have illustrated a joint with large tongue-and-groove facing. Here the gasket bearing-area has been reduced materially to produce a greater pressure per square inch of surface. Note that the gasket is confined in the groove to inhibit failure. This type of joint is an improvement over the old small-tongue-and-groove type (not shown here), which was considerably smaller in diameter and bearing surface. In the small tongue-and-groove joint, it was found that the male member under high bolting pressure would distort and mushroom, sometimes to the extent that the companion flanges had to be forced to permit re-machining or dressing down of the tongue before the joint could be properly re-assembled.

In detail D is shown an entirely different type of flange facing known as the ring-type joint. Here the gasket is in the form of a ring of oval cross-section. This ring is of softer material than the flange, and of different shape from the tapering, flat-bottomed groove in which it fits. A tight joint is achieved by applying sufficient pressure to deform the ring, so that it partially fits the taper of the groove into which it is forced. In recent years, this type of flange has gained in popularity, particularly where high temperatures and pressures are encountered.

If the tightness of a joint depends entirely upon compression between two flat members, any reduction in bolting pressure will have an equal effect on the fit of the gasket. In the case of a ring-type joint, this is not true; only a portion of the reduction in bolting pressure is transmitted to the tapered ring gasket.

When a ring join is used, it is customary to replace the gasket each time the joint is re-assembled.

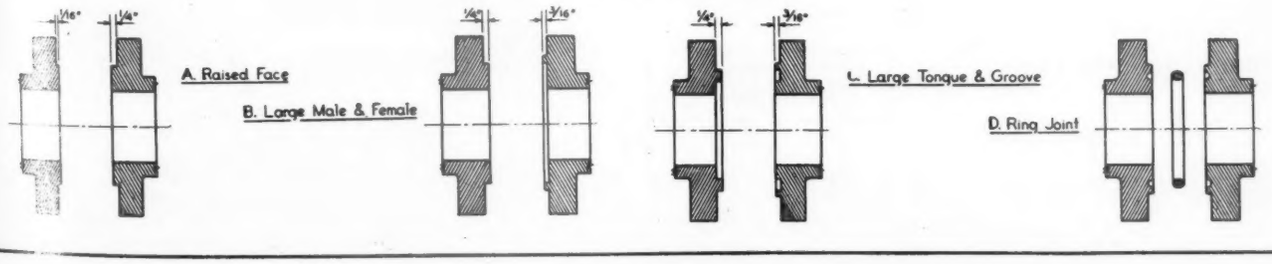
Note again that all of these facings can be applied either directly to the flange, or in the case of a lapped joint, to the pipe lap. In the latter instance, the flange itself will not change, since the gasket surface is machined in the lap rather than in the flange.

Special Lapped Joints

The flexibility of the lap joint installation may be illustrated by detail A in Fig. 11, which shows a type of construction known as the "Globack" lap. With the commonly used Van Stone lap, the manufacturer is

*Vice President, Midwest Piping and Supply Company, Inc.

FIG. 10. Types of flange facings.



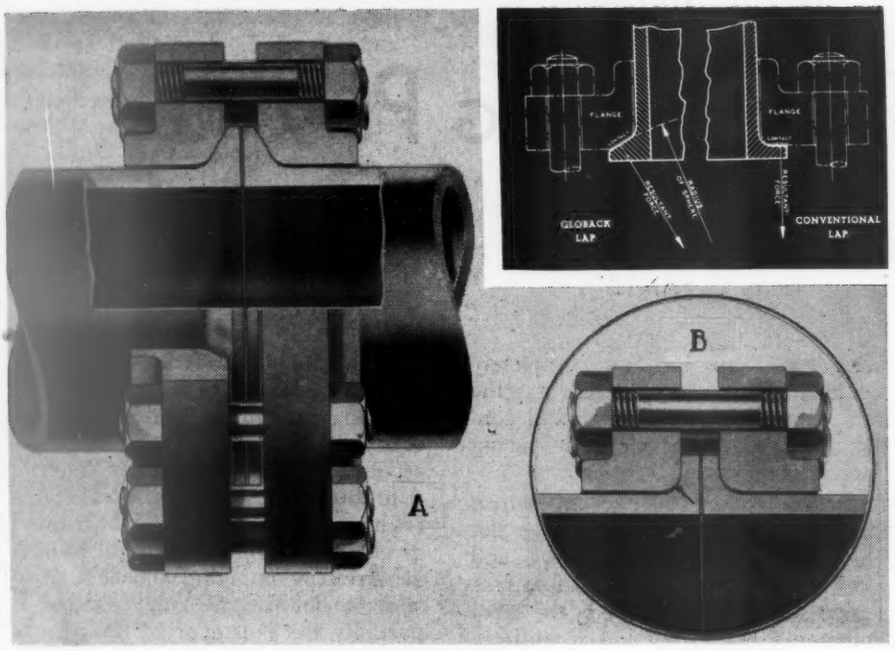


FIG. 11

limited in bolting pressures by the thickness of the lap and the size of the fillet radius. Failures in the Van Stone lap, although rare, have always occurred through the radius toward the inside diameter of the pipe, as indicated in B. To overcome this, our company developed the Globack type, which derives its name from the spherical or globular contour of the back of the lap. At the outer edge, the Globack lap, after machining, is approximately two-thirds as thick as the pipe wall; at the base of the lap, this dimension has increased to approximately one-and-one-half times the pipe wall thickness.

A comparison of (A) and (B) shows the fundamental design difference between the Midwest Globack and the conventional Van Stone lapped joint. The improved metal distribution in the Globack design controls and limits the flexibility of the lap. The bolting force is shifted toward the pipe wall and acts toward the center of the sphere. The lap is therefore subject to a smaller bending moment, and the total parting force is reduced. Globack joints provide a higher factor of safety, at no added cost, in piping for high-temperature and high-pressure service.

Some years ago, we carried out a series of destruction tests on Van Stone and Globack laps. Both were formed on 8-in. extra heavy seamless steel pipe; specimens were then cut from each, carefully machined, and the ends electrically welded to insure uniform tension on both pieces in the testing machine. Dimensions of flange bore, contact surface, etc., complied with the tolerances allowed in good piping practice.

When placed under tension, the specimens were strained in supposedly the same way as if they were in a complete joint, except, of course, for hoop tension due to fluid pressure. As the test conditions were exactly alike, the absence of hoop tension did not affect the comparative results. Note from Fig. 12 that the Van Stone specimen failed in the lap and separated

FIG. 12

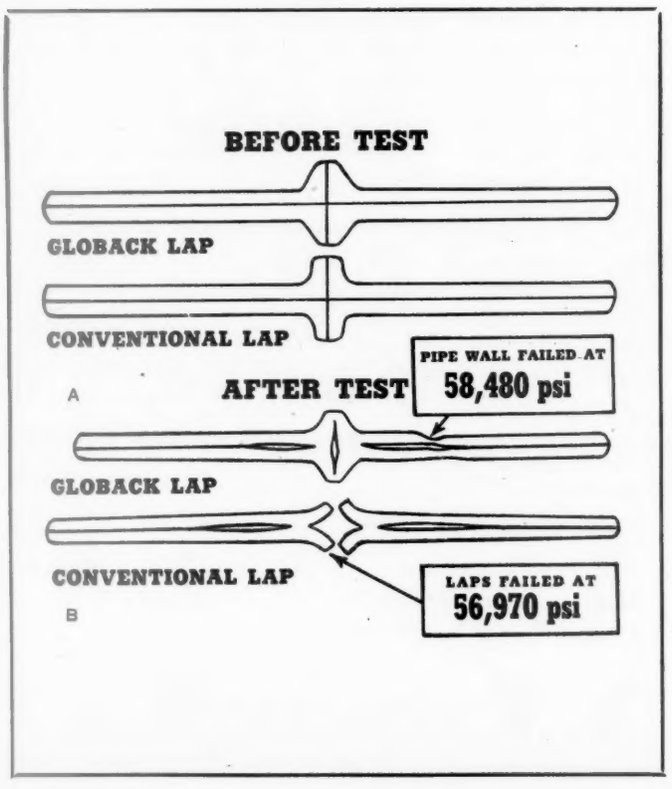
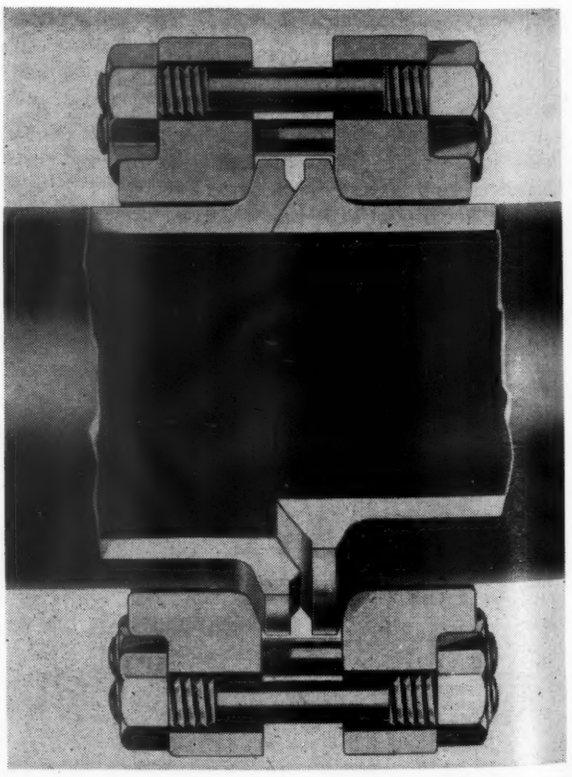
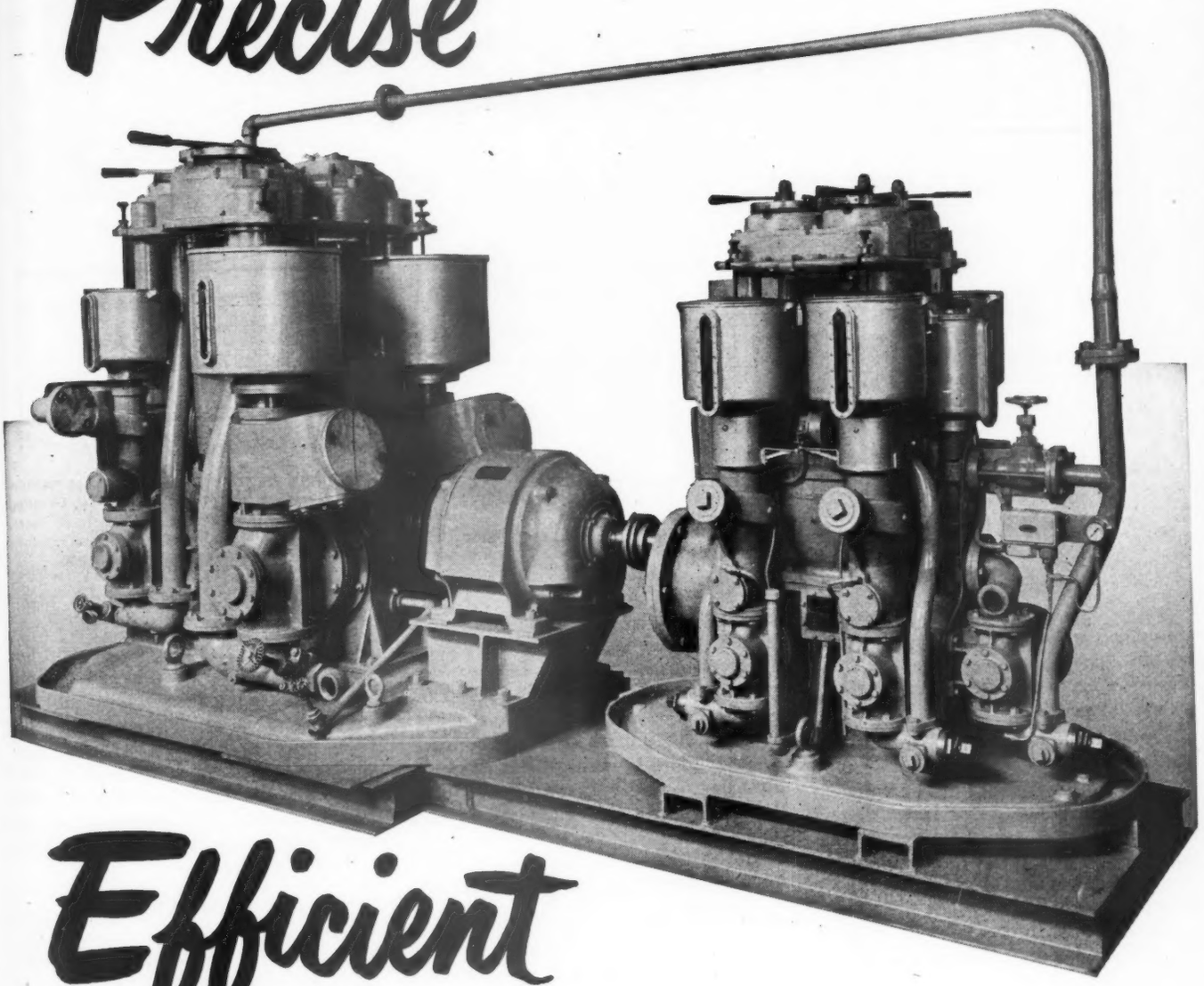


FIG. 13



Precise



Efficient

The oil blending machines shown here are examples of the precise and efficient craftsmanship available at Sun Ship. The versatility of our organization and the diversity of our facilities enable us to build with equal success other refinery equipment, chemical plant and industrial machinery; tankers, cargo and passenger vessels. Here, too, are facilities for dry docking and for making all kinds of marine repairs.

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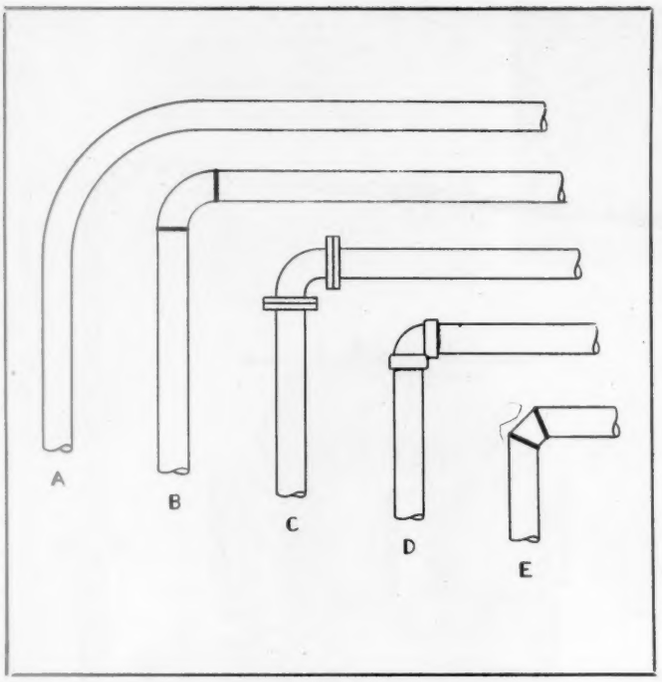
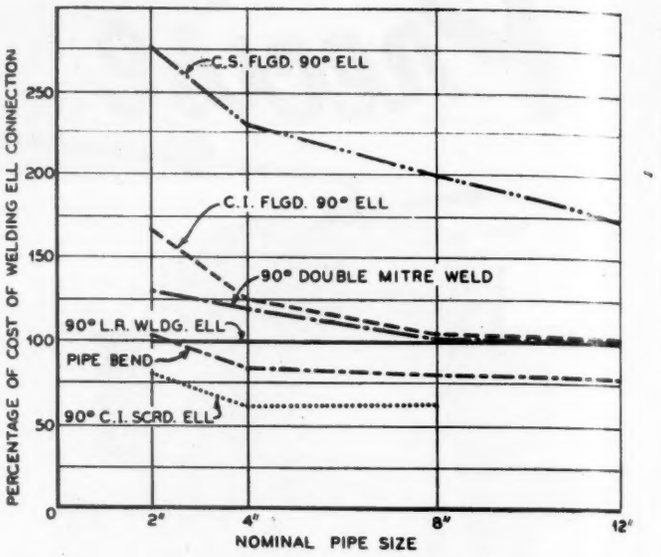


FIG. 14

FIG. 15. Relative Costs of 90 deg Pipe Connections
(Welding elbow assembly = 100)



NOTE: Costs include all necessary materials (pipe, fittings, companion flanges, bolts, gaskets, welding rod) and labor (cutting, beveling or threading, welding or making-on, flange bolting). In all cases, figures include the cost of a sufficient amount of pipe to make all assemblies comparable in center-to-end dimensions.

completely at 56,970 psi; the Globack lap, in contrast, remained intact, and the specimen failed in the pipe wall at 58,480 psi.

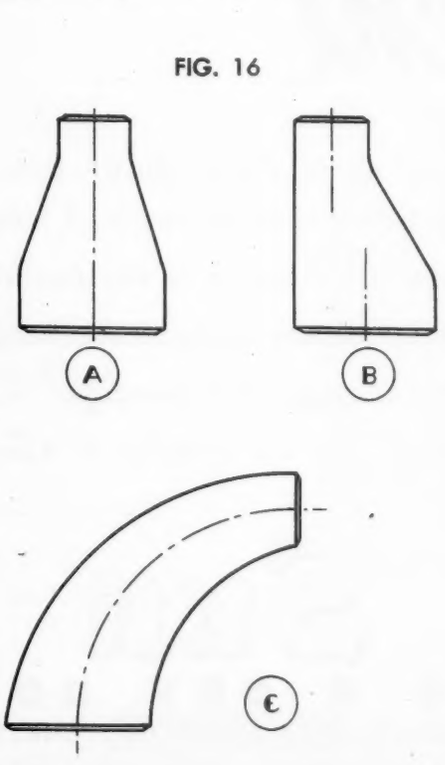
It has been noted that Van Stone and other types of flanged joints removed from severe service show dishing and concentration of force along the edge of the flange or lap face. The unusual construction of the Globack joint permits its use under similar working conditions without this type of distortion. In the last 20 years, literally thousands of these laps have been placed in service. In all cases, the laboratory results shown here have been fully borne out by the behavior of this type of lap in actual service.

A development of lapped piping known as the Midwest joint (Fig. 13) permits assembly without the use of either compression or distortion types of gasket. As said before, the only purpose of a gasket is to compensate for imperfections in machining, either unintentional or deliberate; in the Midwest joint, this need is eliminated by machining the laps to a highly accurate surface with a so-called "cold-water finish."

This type of joint utilizes male-and-female spherical surfaces on the lapped ends and a spherical contour comparable to the Globack on the back of the lap. Thus the Midwest joint retains all the advantages of the Globack, and in addition, permits the union of two pipe ends when the centerlines of the adjacent sections vary in directions by as much as three degrees. Discrepancies of this order can be handled without setting up stresses in either the flanges or the pipe line. Another point in favor of the Midwest joint lies in the fact that the assembly tightens as pressure and temperature rise.

The Midwest male-and-female spherical joint was one of the first assemblies used in the early days of the cracking process. In spite of its minor disadvantages which appear in the difficulty of assembling and disassembling this type of construction, and the care which must be used in handling the accurately machined faces, it has rendered satisfactory service in many high-pressure, high-temperature refinery installations.

FIG. 16



Directional Changes

In selecting pipe connections to accomplish a change in direction of the line, the designing engineer has a choice of the three basic types in Fig. 14: Pipe bends (A); elbows—either welding, flanged or screwed, as in (B), (C), and (D); and mitre-welded elbows (E), commonly called "stove-pipe" assemblies.

The first two types are comparable in many ways, as we shall presently see. The third type, the mitre-welded elbow, is not recomended except in emergency installations: Flow conditions in these segmental assemblies are very poor; the difficulty of welding usually leads to uneven contours and icicles on the inside of the weld; and the cost of such a connection, if made with two welds, is higher than that of the other two types.

Pipe bends are generally made to a radius equal to five times the nominal pipe diameter. It is obvious that flow conditions in a pipe bend would, therefore, be better than in any type of elbow, since the latter are invariably formed to a much smaller radius. Con-

2nd & 3rd cc of "LEAD" are HIGHLY EFFECTIVE

in Terms of Compression Ratio

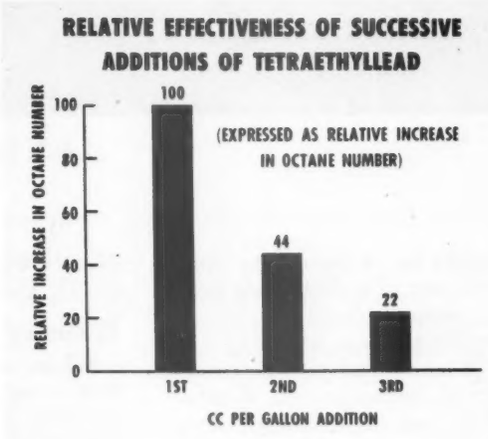


CHART 1.

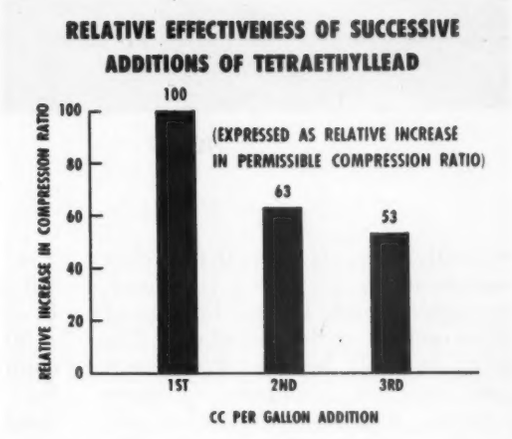


CHART 2.

The usual way of looking at tetraethyllead effectiveness is illustrated in Chart 1. This shows the average relative increase in octane numbers due to the addition of 1, 2 and 3 cc of tetraethyllead to twenty current base gasolines. (The effectiveness of the 1st cc is considered to be 100%.) In terms of octane numbers, there appears to be a marked tapering off in effectiveness with increase in concentration to 44% for the 2nd cc and to 22% for the 3rd cc.

On the basis of engine performance, this diminishing unit effectiveness of tetraethyllead with increases in concentration becomes much less. Consider the effectiveness of tetraethyllead concentrations in the same fuels, demonstrated in cars on the road, from the standpoint of average increase in compression ratio obtainable (Chart 2).On this basis, the 2nd cc is 63% as effective as the 1st, while the 3rd is 53% as effective. *Thus the 3rd cc is 84% as effective as the 2nd cc.*

Refiners interested in providing the highest measure of antiknock performance on the road for each dollar of refining cost often obtain substantial economic benefits from periodic re-evaluation of the use of larger amounts of tetraethyllead per gallon. Ethyl technologists gladly assist refiners in their efforts to obtain the best fuel performance for each dollar invested in "Ethyl" antiknock compound.

CHART 3.— This chart shows that the units going up the octane scale become larger and larger in terms of permissible increase in compression ratio

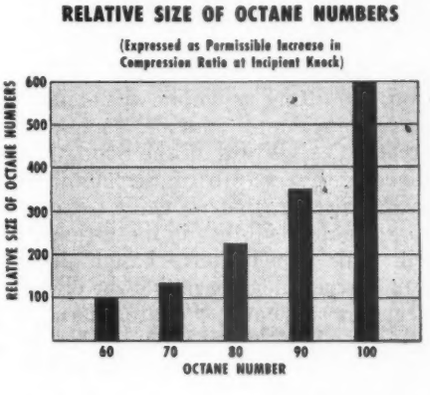


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FIG. 17

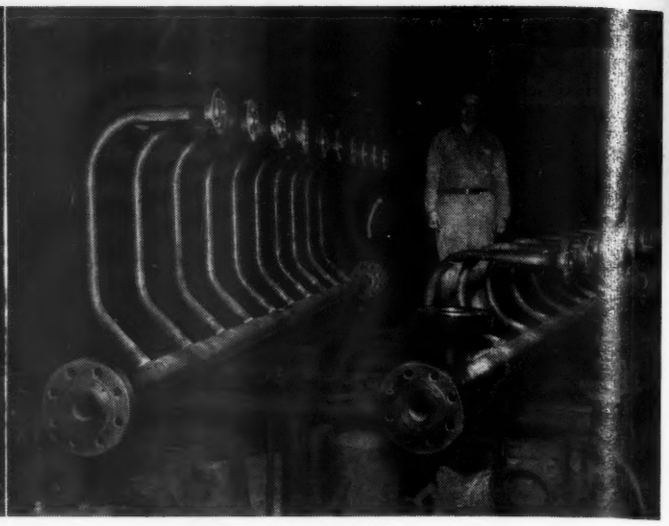

FIG. 18

sequently, it is safe to say that if other considerations may be eliminated, pipe bends should be used in place of either welded or flanged elbows. The fitting assembly, however, has advantages from the standpoint of space economy, and, since the fittings are usually carried in local stocks, the additional advantage of immediate availability. Accordingly, in practical application refinery piping will probably include a combination of pipe bends and elbows, each used where its applications best serves the purpose of designing and constructing engineers.

There is often a question in the minds of piping engineers as to the relative flexibility of bends and elbows. Tests in our laboratory have shown that the flexibility of these two assemblies would be practically identical, given the same amount of pipe in each. Consequently, if fabricated with the same center-to-end dimension, the fitting assembly will contain more pipe, and provide somewhat greater flexibility than the bend. The shape and structure of the elbow is such, however, that we cannot expect appreciable flexibility in the fitting itself. Our conclusions, based upon actual experiments, are that the elbow offers no greater flexure than a straight piece of pipe equivalent in length to the center-to-end dimension of the fitting.

In a 90 F connection made with a flanged elbow, almost absolute rigidity exists in the fitting, subjecting the flange and the adjacent pipe to high stress concentration. This, combined with the inability of the bolted joint to withstand tortional forces, causes numerous gasket failures and leaks.

Let us glance briefly at the relative costs of these 90 F connections (Fig. 15). It might be of interest to point out that the cost of a shop-made bend is closely comparable to the cost of a 90 F welding elbow assembly (including the amount of pipe necessary for identical center-to-end dimensions). The cost of a flanged elbow assembly of comparable strength, however, is considerably greater than either of the two other types. The relative costs shown in this graph are subject to the same reservations described previously in comparing costs of flanged connections; they will vary from place to place and from job to job, and the comparison is intended only as a rough guide.

Reduction in Line Area

At many points in a piping system, it becomes necessary to reduce the size of the line. This is generally accomplished by the use of reducing fittings, either concentric or eccentric with the center of the line (Fig. 16). The eccentric reducer (B) is primarily used to eliminate pockets in horizontal lines such as drains, bleeders, etc. It should be realized that the eccentric reducer tends to produce an unequal stress condition in the line when subjected to expansion and contraction; this, added to increased cost of the eccentric fitting, woud indicate the use of concentric reducers (A) wherever possible.

As there are generally turns in a line at points where reduction of area is required, a reducing elbow is often employed to accomplish both purposes, and at the same time, to improve flow conditions and reduce cost. Reducing elbows such as the one shown in (C), Fig. 16, are available as stock fittings in sizes from 2 to 12-in. and in reductions to one-half size (e.g., 4-in. reducing ells are carried in sizes 4 by 3½-in., 4 by 3-in., 4 by 2½-in. and 4 by 2-in.)

Diversion or Separation of Flow

When we come to a diversion of flow or separation of the line into two or more branches, we have several choices of connections: Flanged or welding tees, headers or manifolds with welded nozzle connections; and especially formed and welded assemblies such as those shown in previous photographs.

When there is a considerable distance between branch connnections, it is generally deemed best to use welding tees. Where several openings can be placed in one length of pipe, it is usually better to fabricate a header with welded nozzles. A very good example of this is shown in Fig. 17. We might say that it requires considerable experience, as well as carefully developed layout and welding techniques, to produce headers of this type. All flange faces must be on the same level and exactly spaced. Incidentally, these headers were fabricated for a Shell Oil Company subsidiary. We understand that they were installed as a heat exchanger unit, in which straight lengths of flanged pipe were interposed between the two headers.

In Fig. 18 is shown another example of what can be done in designing for both compactness and flexibility. These headers were fabricated for an oil refining process operating at 1500 psi and 600 F. Note that all flanges are machined with large tongue-and-groove facing. It is difficult to imagine the appearance of these headers and the space that would be required had they been made from flanged fittings. * * *

Part 3 will be published soon.

THE TECHNICAL FORUM

Questions on the petroleum and natural gas industries' technology, chemistry, engineering, and operating problems are answered each month by widely recognized authorities.

Instrument Requirements

Q What are the air capacity requirements, and the necessary items of equipment needed to service the instrument assembly for a natural gasoline plant of, for example, 100,000,000 cu ft of wet gas per day, which includes recycling the major portion (86,000,000 cu ft) of the stripped gas at 3000-4000 psig to the field?

M. E. R.

A The schematic flow diagram illustrated as Fig. 1 indicates the essential items of equipment needed for a natural gasoline plant.

It will be noted that this diagram includes the following instrument assemblies:

Recording flow controllers	(RFC) 6
Liquid level controllers	(LLC) 9
Recording temperature controllers	(RTC) 5
Recording pressure controllers	(RPC) 3
Ratio recording flow controller	(RRFC) 1
Back pressure regulators	(BPR) 4

A detailed design of this plant, however, will probably indicate the necessity of constructing two primary absorbers and operating them in parallel in order to reduce the physical size of each tower. Such duplication would result in additional instrumentation for the extra tower.

The instrument companies recommend about 0.50 CFM of free air for each relay present. If all motor valves were supplied with valve positioners, this would establish the air capacity requirements for this plant at about 24 CFM of free air. This air should be supplied at a pressure of about 30 psig.

Adequate servicing of the instrument assemblies in any plant requires a well equipped, instrument shop, well trained personnel, and a careful system of records.

The shop facilities needed for instrument repair are widely divergent in nature, because both delicate instrument sub-assemblies and large cumbersome motor valves will have to be repaired. Generally speaking, the shop men have to be capable of pursuing the crafts of machinist, pipe fitter, sheet metal worker, electrician, painter, welder, and blacksmith.

The shop should be centrally located in the plant with respect to the operating units to make transportation a minor problem.

It should be provided with illumination sufficient for detailed work, either in the day or night, as instrument repairing is a 24-hour job.

The tools necessary for adequate servicing are very numerous. In addition to the ordinary tools, pliers, wrenches, screwdrivers, etc., there are several specialized items that are particularly useful in instrument work. A pneumatic drill motor is a must for operation in hazardous locations. Pneumatic impact wrenches are helpful for valve work. A saw gun is a time saver for panel cuts. A small lathe, drill press, grinder, and painting facilities are necessities.

In addition to these items, which are mainly for repair work, a complete testing arrangement should be installed for checking the repaired instruments.

Instruments may be classified generally in four categories: Pressure, temperature, flow, and liquid level meters. There are other specialized instruments used for ph, color, humidity, infra red, etc., measurements but their repair will not be considered here.

Flow and pressure measuring instruments are very similar in operating nature because they both measure pressure differences. A flow meter measures the differential pressure across an orifice, venturi tube, etc., and a pressure meter measures the difference in pressure between some enclosed vessel and the atmosphere. Consequently, the equipment needed to test a repaired meter simply consists of several meters and manometers to cover the pressure differentials involved. The gages should cover the following ranges:

1. 0-30″ Hg vacuum
2. 0-30 psig
3. 0-100 psig
4. 0-600 psig
5. 0-1000 psig
6. 0-2000 psig
7. 0-5000 psig

The manometers should be as follows:

1. 0-30″ Hg
2. 0-20 psia
3. 0-100 cm Hg
4. 0-100″ water

These instruments may be manifolded to a common header, which in turn is connected to a good vacuum pump, a pressure system capable of producing a maximum pressure of 5000 psig, and a precision dead weight gage tester. The multiple number of gages plus the dead weight tester will allow accurate readings to be obtained in any pressure range.

Temperature measuring instruments are widely divergent in nature and the exact repair facilities should be determined by the instruments in use. Most recycle plants, however, use 4 types of temperature measuring elements; i.e., thermocouples, gas filled systems, liquid filled systems, and vapor filled systems. Testing the filled systems usually amounts to a simple calibration against known temperatures. If extreme accuracy is desired, the temperature bath may be meas-

ured with a platinum-platinum rhodium thermocouple or thermometer with a National Bureau of Standards calibration.

Repair of thermocouple measuring systems, because of the long leads, multiple junctions, and small voltage, involves more elaborate testing equipment than do filled systems. The equipment should include the usual millivolt potentiometers covering the range from 0 to 110 mv in steps, a decade resistance box, a Wheatstone bridge, vacum tube volt-ohmeter, megohmer, and a precision d'Arsonval galvanometer. The repaired instruments may be checked by using a constant temperature furnace.

Facilities should also be provided for checking the other items of equipment associated with instrumentation. These items include; orifice plates, relief valves, pressure gages, combustible gas analyzers, alarms and signal systems, and the large number of control valves.

The instrument maintenance crew for this type plant should consist of about 4 men if a 24-hr maintenance schedule is to be maintained. The crew chief should have a knowledge of the plant processes, and a working knowledge of the fields of electronics, hydraulics, and mechanical engineering. Preferably he should have a degree in engineering plus several years of practical experience in the field of control and measurement. He should have the ability to get along with the operators and administrative heads and should be able to teach recruits the principles of instrumentation.

The large instrument companies conduct excellent training courses that will quickly develop a trainee into an experienced instrument man.

A system of complete records and periodical maintenance check system should be established to ward against costly breakdown. The records should include a detailed history of each instrument, its purchase date, model and serial numbers, plant location, repairs, and maintenance checks. The maintenance checks depend on the particular instrument but a typical program for a flow meter is developed below.

The program may be divided into four groups:

1. Orifice plant and piping
2. Meter body
3. Recording mechanism
4. Operating conditions

The orifice plates and piping should be checked at each turn around. The orifice plate should be visually inspected for flatness, the upstream edge must be sharp and square, and there must be no corrosion or accumulation of material. The connecting piping should be clean, leakproof, and the seal pots level.

The meter body should be clean, checked for zero and checked for calibration. The pen linkages should be free moving and well lubricated.

The recording mechanism should be checked periodically for clock accuracy, the housing cleaned, pens repaired, and moving parts lubricated.

Chart and integrator factors for any orifice meter are correct only for a fixed fluid composition at a set temperature and pressure. For this reason periodic checks of these variables should be made and the operators provided with the necessary corrections whenever necessary.

G. L. Farrar
H. M. Platt

AN INVALUABLE SERVICE

This Forum is a meeting place each month for engineers, technologists, students, operators, and all others interested, where each may profit not only by answers to his own knotty questions, but learn as well by reading the answers to the questions of others in the industry, answers submitted by the leading scientists and engineers in the world of oil and gas.

Address all questions to Technical Forum Editor, Box 1589, Dallas 1, Texas. Send them in right away while you think of it.

Effect of S Compounds On Knock

Q What are the comparative effects of the following sulfur compounds in decreasing the anti-knock effect of TEL in spark-ignition fuels; (a) Hydrogen sulfide?; (b) Thiophene?; (c) Polysulfides?; (d) Mercaptans?; (e) Thioethers? and (f) disulfides?

C. W. B.

A Published data show that equivlent sulfur concentrations reduce TEL in decreasing order: H_2S, thiols, disulfides, sulfides, thiophenes.

C. W. Rippie.

High vs. Low M.P. Greases

Q For general lubrication is a high melting point grease more or less desirable than a low melting point grease? Will you please discuss the technical and practical knowledge behind and supporting your answer to the first question?

L. E. C.

A For general lubrication a high melting point lubricating grease is more desirable than a low melting point lubricating grease because many points of application operate at temperatures above that at which a low melting point product would be satisfactory. Further, the former lubricant provides a greater factor of safety. Thus, the normal operating temperature of a specific bearing might be 150 F or lower but a mechanical defect might develop that would cause heating with a consequent rise in temperature to above 200 F. In such a case the low melting point lubricant would not be satisfactory. The fact that all of the multi-purpose lubricating greases, which are gaining much favor, are high melting point products, bears out the above statements.

Of course the terms high melting point and low melting point are relative, but one thinks of ordinary calcium base lubricating grease, with a melting point of 185 to 210 F, or aluminum base lubricating grease, with a melting point of 200 to 235 F, as low melting point products, while lubricating greases made with barium, lithium, or sodium soaps are high melting point products with melting points ranging from 300 to 400 F or even higher. In the latter classification might also be included oils thickened with carbon blacks, fine silica, or bentonite to which has been attached an organic radical. This latter group does not have actual melting points but change at high temperatures due to the oil being either driven off or charring.

The standard method, for determining the characteristic in question, as described by the ASTM (D 566-42) employs the term Dropping Point rather than melting point and states that this "is the temperature at which the lubricating grease passes from a semisolid to a liquid state under the conditions of the test." Actually the dropping point test is used primarily for a control test and to indicate uniformity of the product. It is only roughly indicative of the temperature at which the lubricating grease can be used. Before the present standard method, which uses a glass thimble with a 7/64 in. opening for the fluid grease to drop through and which leaves the thermometer bulb free of insulating grease, was adopted, some half a dozen methods were in use. The variation in dropping point on the same sample with these various methods might be over 100 F (1).

Lubricating greases do not have sharp melting points as do pure crystalline compounds, but, as they are amorphous products, they go through a gradual softening over a range of

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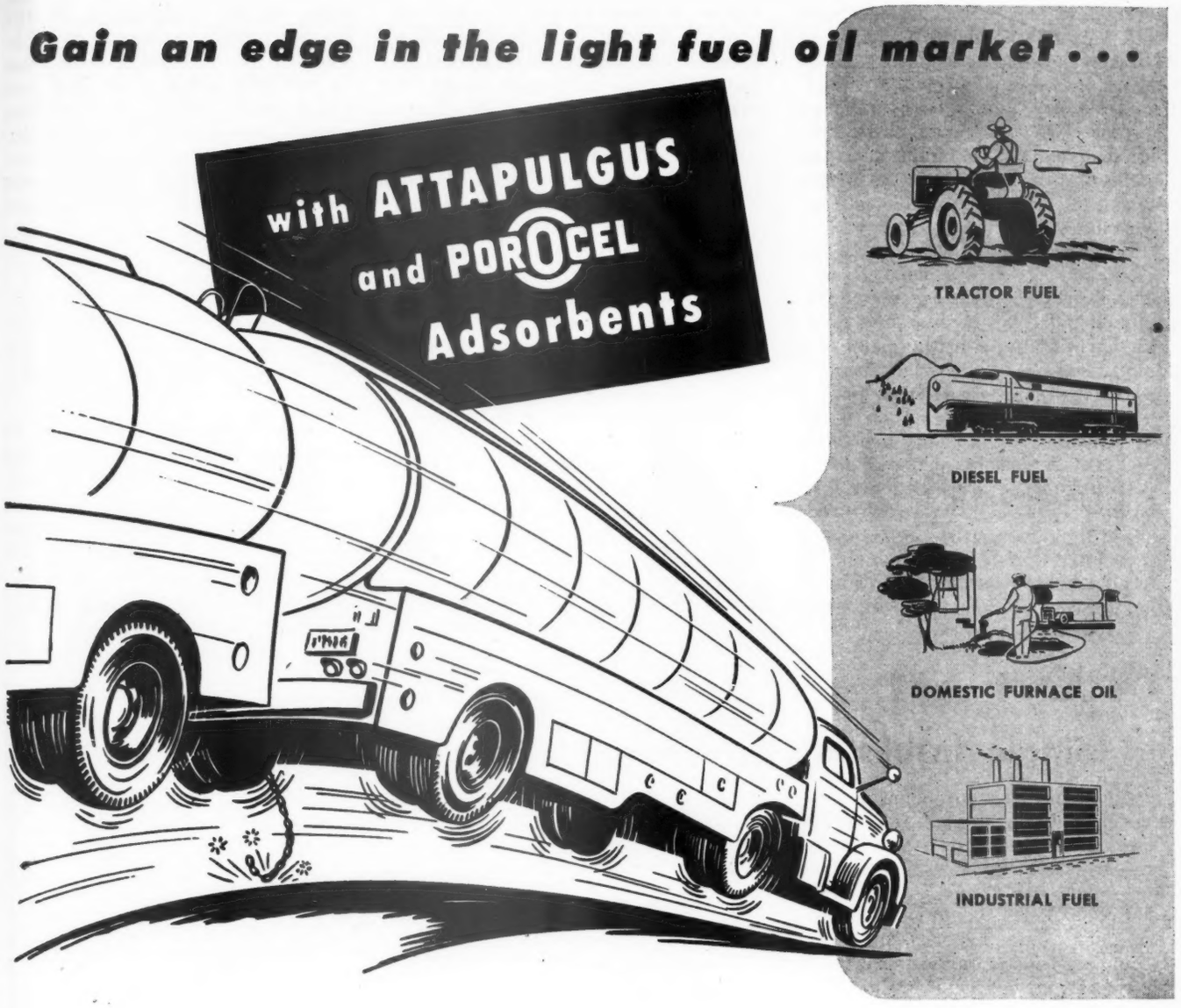

In a highly competitive market for distillate fuel oils—Diesel, domestic furnace, tractor, industrial—the refiner who places emphasis on high quality in his products has a decided edge. In fact, selling strategy often is based on points of superiority that assume smaller stature at other times. This applies to other products too—absorption, enrichment, smudge, and insecticide spray oils.

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several degrees when heated. Such softening may be due to a change in phase of the soap or it may be due to the action or loss of "peptizers" which act as fluxes. The soap of course may be present in a so called, crystalline, liquid crystalline or liquid state and as this changes from one of the former states to the latter the product will become fluid.

The "peptizers" may consist of water, fatty acids, alcohols, glycols, phenols, etc. The higher alcohol, glycerine, is a good illustration of a product that will alter a melting point of a soap. In the case of calcium base lubricating greases made from fat the dropping point is lower than if the corresponding fatty acids had been used. This is because of the glycerine split off from the fat which remains in the finished product. Two such products of the same consistency may vary by 10 to 12 F in dropping point.

If the grease structure depends upon the presence of one of these "peptizers", removal of this product will result in destruction of the lubricating grease. Thus, calcium base lubricating greases almost universally contain a small proportion of water which acts as a "tie" between the soap and the oil. Once this water is driven off the soap and oil separate and instances have been observed where the soap deposited in grease channels and clogged them. Such an occurance would not have occured with a high melting point lubricating grease.

Very few producers of lubricating greases recommend the use of such products at temperatures approaching the dropping point. As a rule the maximum temperature for use should be at least 50 F below the dropping point of the lubricant and the spread between dropping point and a safe service temperature maximum frequently exceeds 100 F. This again points to a high melting point product.

The recommendations of the Ball and Roller Bearing Engineers' Committee of the Anti-Friction Bearing Manufacturers Association is of interest in this connection. This group has set up a temperature range over which four groups of lubricating greases are expected to give satisfactory lubrication and has also recommended a minimum dropping point for each group. These are tabulated below:

Group	1	2	3	4
Group	1	2	3	4
Use	General purpose	High temp.	Medium temp.	Low temp.
Operating range	—40 to 250 F	0 to 300 F	32 to 200 F	—67 to 200 F
Min. dropping point	300 F	350 F	300 F	300 F

From the above it is evident that for anti-friction bearings a high melting point lubricating grease is essential.

References: 1. Report on Grease Dropping Point Methods. J. C. Zimmer, The Institute Spokesman Vol. VII, No. 12, page 1 (March, 1944).

B. & M.

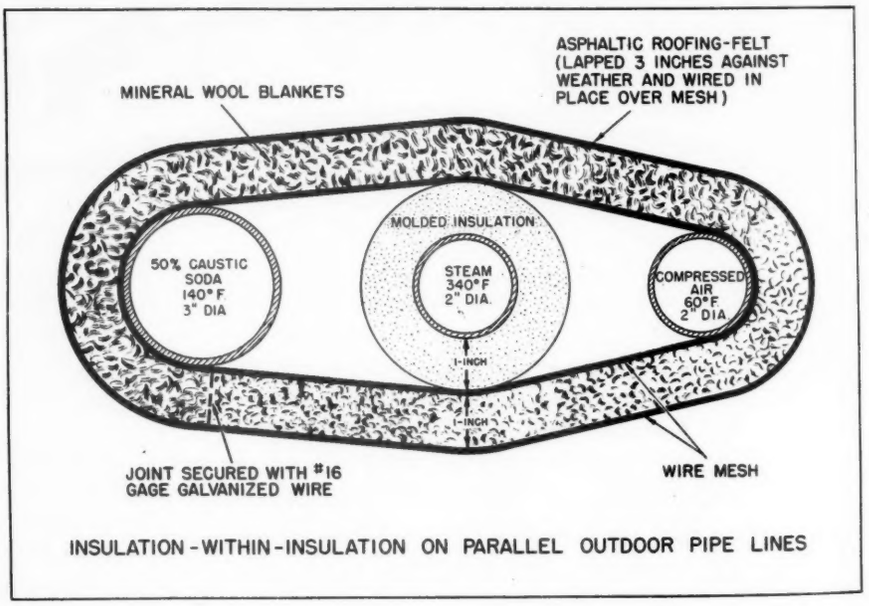
PLANT AID

Single Insulation Covering for Steam and Process Lines

One of the major problems in a refinery or chemical plant is that of "tracing" a process or steam line to prevent condensation or 'freezing' of the contents, as steam, asphalt, wax. or wax distillates, and numerous other materials. These materials must be maintained in a liquid, pumpable state, but must not be held at too high a temperature.

Typical of the procedure employed in this situation is to place a steam or hot water line and the process line near to and parallel to each other, and to insulate the two within a single common layer of insulating material, whatever may be used. In the event of 2 process lines requiring heating they may be arranged on opposite sides of the heater line and the 3 are enclosed in common insulation.

Often it is found that the process lines may be overheated under these conditions, especially if the steam line carries steam at a higher than necessary temperature, destined eventually for other purposes elsewhere in the plant, such as heating a process kettle, driving a turbine or steam pump, etc. To prevent this overheating and still maintain the process lines at or above the required minimum temperature, the practice has been developed for double-insulating these lines. For example, the steam line is partially insulated so as to allow the escape of only enough heat to the adjoining lines to keep the contents from solidifying. After insulating the steam line, the entire 3-line assembly is enclosed in an overall, common covering as indicated in the drawing. In this manner both purposes are served, the process lines are heated to or above a minimum temperature, the steam line is protected to reach its final destination —if other than that of 'tracing' the process lines—with the required temperature, the process lines are not overheated, and a minimum of heat is lost to the surrounding atmosphere.


ASPHALTIC ROOFING-FELT (LAPPED 3 INCHES AGAINST WEATHER AND WIRED IN PLACE OVER MESH)
MINERAL WOOL BLANKETS
MOLDED INSULATION
50% CAUSTIC SODA 140° F 3" DIA
STEAM 340° F 2" DIA
COMPRESSED AIR 60° F 2" DIA
1-INCH
1-INCH
JOINT SECURED WITH #16 GAGE GALVANIZED WIRE
WIRE MESH

INSULATION-WITHIN-INSULATION ON PARALLEL OUTDOOR PIPE LINES

In one instance of using this method, a 1-in. molded sectional pipe insulation was placed over the 2-in. steam line, and held by metal bands. Then mineral wool blankets between wire mesh facings are cut and shaped around the 3-line assembly, wired in place with 16-gage galvanized wire, and abutting ends and blanket edges fastened together with the same wire laced through the mesh coverings. Being outdoors, the whole was covered by asphaltic roofing felt, lapped 3-in. and bound on with galvanized wires on 6-in. centers. * * *

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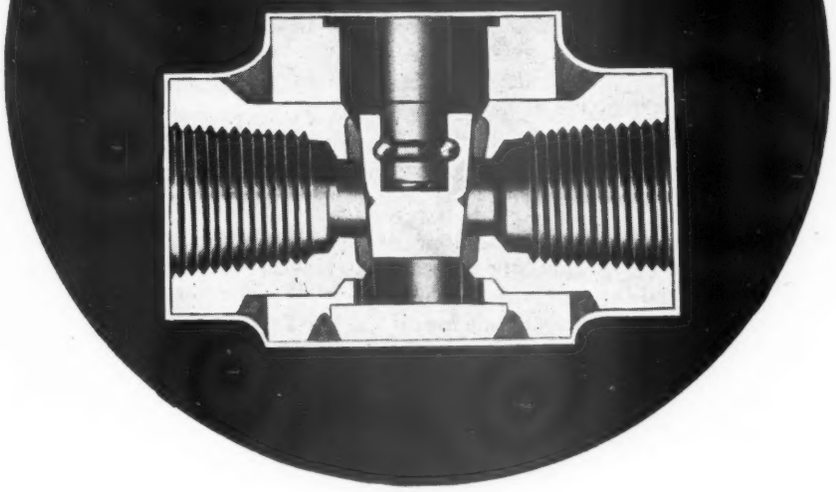

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Petroleum Refinery Instrumentation*

Economics of the rapidly growing use of instruments and their role in refining operations and pilot plants

DOUGLAS M. CONSIDINE†

In 3 Parts—Part 1

THIS paper is not intended to dwell on the nuts, screws, and bolts of instrumentation, but rather on a consideration of the role which instruments and controls play from the standpoint of petroleum refinery management. In the first part of the paper, I shall attempt to outline some of the general economic factors which justify the rather extensive acceptance of instrumentation by the oil industry. In the latter part of the paper, I shall describe two important trends taking place in petroleum refinery instrumentation—first, the use of automatic analytical methods for process control—and second, the evolution and impact of the graphic panel upon presently accepted process control.

Your Investment in Instrumentation

Let us consider your industry's investment in measuring, recording, and controlling instruments for a few minutes. Although there is no single source of information of this type, it would appear that your industry has invested one-hundred million or more dollars in these instruments over the past twenty-five year period. About 40 per cent of this figure has been purchased since 1945. It is not unusual to find a refinery today where well over a million dollars has been invested in instrumentation.

This investment varies, of course, with the type of process. Some representative figures, expressed as the percentage of total capital equipment costs for a new plant, are as follows:

- 3 per cent for a solvent dewaxing plant.
- 4 per cent for styrene and ethylene plants.
- 3.4 per cent for TCC units.
- 4.9 per cent for gas recovery units.

Compare these figures with 1.5 per cent for the average textile process and with 2 per cent for the average chemical process.

You may be interested in noting how your industry compares with others in its use of instrumentation.

Year	Petroleum	Chemical	Steel	Food
1935	$10,000	$3,570	$ 7,800	$ 610
1940	11,100	4,000	9,850	580
1945	17,500	3,050	10,700	1,200

This table is based on the dollar volume of new industrial instruments per million dollars of capital expenditures for new plants and equipment in the petroleum, chemical, steel, and food industries. To make all figures comparable, the data have been adjusted for commodity price and dollar fluctuation on the basis of 1939 equals 100. The figures include only new instruments and do not embrace control valves, electrical wiring, pneumatic tubing and the like—so that the total investment in instrumentation on an installed basis would be two or more times that shown. However, these figures do serve to compare one industry with the other.

Note how the petroleum industry's investment in instruments of $10,000 per million dollars in 1935 increased to $17,500 in 1945. This is a phenomenal increase, but one that is in comparison with the rapid technological strides of your industry. The petroleum industry's investment of $17,500 per million dollars in 1945 is to be compared with the steel industry's investment of $10,700; and with the over-all chemical industry's investment of only $3,050 per million dollars. Only in the food industry—has the rate, but certainly not the volume of investment in instruments been comparable.

Evaluating Economic Role

With so much money invested in tools of control by your industry, you undoubtedly will agree that it is in order here today for us to review some of the economic reasons which warrant these large expenditures. If some of the examples I shall cite seem elementary, it is only because they illustrate these economic factors more clearly than less simple examples might convey.

The existence of practically every instrument and control in a refinery can be justified by one or more of these reasons:

Cut costs

- . . . by freeing labor for other duties
- . . . by more efficient use of fuels
- . . . by supplying cost accounting data
- . . . by simplifying processing methods
- . . . by decreasing size and number of process vessels

Increase production

- . . . by upping throughputs
- . . . by reducing down time
- . . . by increasing yields and quality

Protect investment

- . . . by safeguarding equipment
- . . . by reducing hazards to life and limb

These reasons are not new or unusual. They are the same reasons which motivated your industry years ago to look toward instrumentation as one of the tools for improving petroleum processes. Nevertheless, it is well to take inventory of these factors on occasion rather than to fall into a groove of always taking them for granted.

If the instrument engineer in your plant advances one or more of these reasons when he requests an appropriation for instruments and automatic controls, chances are his requisition is a valid one and should not go unheeded. The rapid growth in stature of the instrument engineer and his department in numerous refineries is a fitting testimonial to the operating economies he has effected through an intelligent application of these tools.

Typical Refinery Case Histories

Let us consider a few typical refinery applications and case histories to economically justify the instrumentation concerned.

Shown in Fig. 1 schematically is a typical charge stock heater. Immediately, today, when we think of instrumenting a heater of this type, two variables come to mind—the rate of flow of charge to the heater—and the outlet temperature of the heated charge. Elementary—yes—but why must these

*Presented at the thirty-eighth annual meeting of the Western Petroleum Refiners Association, San Antonio, Texas, March 27-29, 1950.

†Manager of Market Extension, Industrial Division, Minneapolis-Honeywell Regulator Company, Philadelphia, Pennsylvania.

MODERATELY PRICED SMALL STEEL VALVES FROM THE COMPLETE CRANE LINE

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Here's a valve value made possible by Crane Co.'s finer facilities for *quality* mass production. These low-cost, small steel gates are specially designed for a wide range of tough services in petroleum processing, in oil and gas fields. They readily withstand rough usage, piping and pressure strains, and extreme variations in temperature. The features below show how and why they do it.

COMPACT OVERALL DESIGN—size for size, these valves are more compact than the usual high-pressure design—at no sacrifice of strength.

TIGHT UNION BONNET JOINT—heavy steel union ring with long, precision-cut threads pulls up easily, stays tight, protects against distortion when joint is opened. Male and female bonnet joint with soft iron gasket eliminates possibility of gasket blowout.

LEAKPROOF BODY SEAT RINGS—are securely rolled into the body. No danger of leakage around ring. Cannot loosen in service.

FULLY GUIDED SOLID WEDGE DISC—cannot get out of line or jam in body. Disc drag and wear on seating surfaces are minimized.

GET DESCRIPTIVE FOLDER AD-1741 for more data on these valves. Gives sizes, dimensions, and service recommendations. Ask your Crane Representative for a copy or write direct. These valves also listed in your Crane No. 49 Catalog, P. 223.

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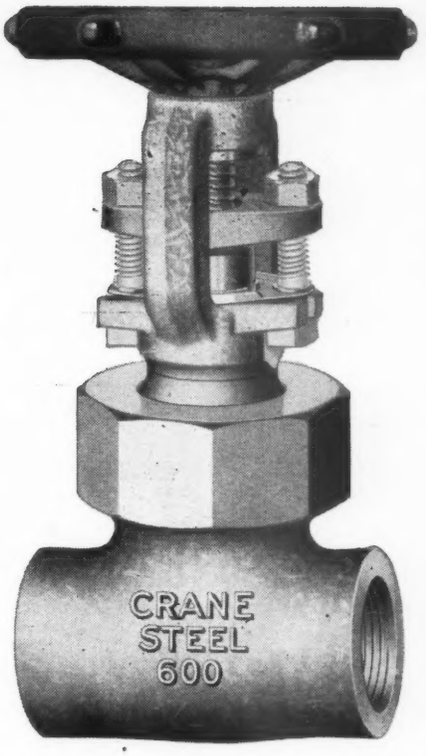
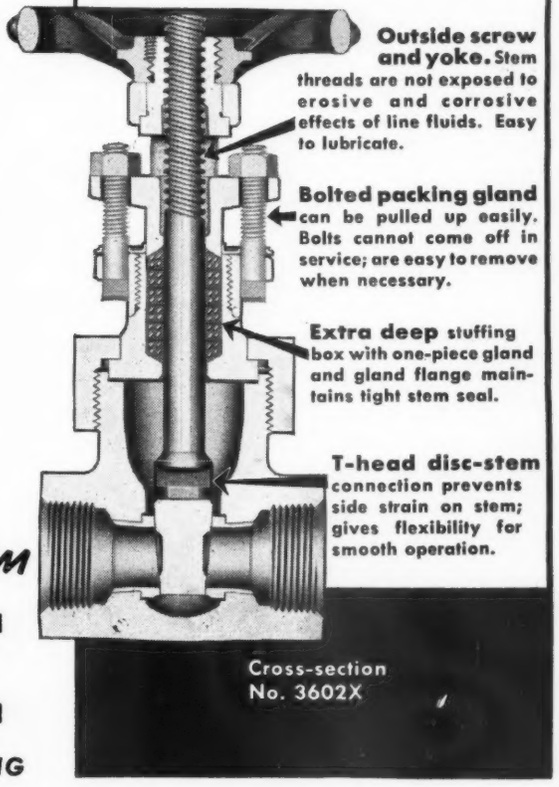


No. 3602X, 600-Pound Small Steel Gate for oil or oil vapor up to 1000° F. Exelloy to Exelloy seating. Sizes: ¼ to 2-inch. Screwed or welding ends.

Easy to operate . . . Easy to service



Outside screw and yoke. Stem threads are not exposed to erosive and corrosive effects of line fluids. Easy to lubricate.

Bolted packing gland can be pulled up easily. Bolts cannot come off in service; are easy to remove when necessary.

Extra deep stuffing box with one-piece gland and gland flange maintains tight stem seal.

T-head disc-stem connection prevents side strain on stem; gives flexibility for smooth operation.

Cross-section
No. 3602X

EVERYTHING FOR EVERY PIPING SYSTEM

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VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

FIG. 1. Charge stock heater control system.

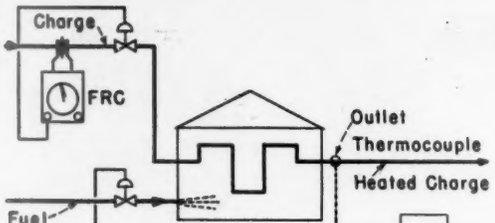
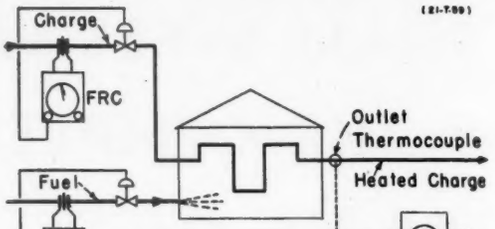


FIG. 2. Cascade control system for charge stock heater.



variables be reliably controlled? Why will it cost you money if these variables are not properly regulated?

In the close coupling of process vessels as practiced in the modern refinery, there is a minimum of surge capacity allowed. This close coupling, of course, has a sound economic background. Why invest in extra tanks and vessels if, through the proper application of automatic controls, the need for these vessels can be overcome?

Certainly, one basic reason for reliable flow control of the charge to a heater is to establish a steady throughput to the entire unit. Vary that charge flow frequently and appreciably and you start a chain of events that upsets the entire unit, since little or no surge capacity is available to iron out these variations before they pass on from one vessel to the next.

Let us omit reliable charge stock flow control for a moment and observe what can happen. First of all, an unsteady flow of charge will make difficult or impossible accurate heater outlet temperature control. In most units, the charge picks up a substantial temperature rise by passing through several heat exchangers wherein product streams from fractionating towers or other vessels are cooled by the incoming charge. Let us suppose that the charge flow decreases. How will this affect our system of heat exchange? Less heat will be picked up by the charge from the product stream heater exchangers, leading to difficulties in tower operation. Obviously too, a smaller charge flow will cause the charge to enter the heater at higher than design temperature. Because of comparatively long lags in the heater, the heater outlet temperature will run high—temporarily at least, further aggravating the upset condition.

What will occur if the heater outlet temperature were allowed to run rampant? For one thing—if the temperature goes higher than that required for optimum operation of the process, fuel is wasted. But more important—a hot feed to a tower will cause excessive vapor temperatures, which in turn, will require considerably more reflux if side streams of the desired specifications are to be produced. More reflux means greater pumping costs and, of course, there is a limit to the quantity of reflux which can be used before the tower will choke.

Conversely, if the outlet temperature is permitted to run lower than that required for optimum operation, the required separations in the tower will become difficult to obtain. Reflux requirements may be so small as to become uncontrollable, since the pumps and valves are designed for certain minimum flows below which operation is difficult or impossible.

Temperature control of cracking furnaces, of course, is even much more critical than for the average heater. Operate the furnace a few degrees under the optimum temperature for the cracking reaction and your yield falls off. Operate the furnace a few degrees over optimum temperature and coking will occur in a very short time, causing costly down time and, of course, increased wear and tear on the furnace tubes because of turbining.

These rather elementary examples illustrate at least three of the economic reasons for instruments shown on the previous slide; namely, increased production:

—by maintaining optimum throughputs,

—by reducing down time, and

—by increasing yields and quality.

What is shown in Fig. 1 may be considered the very minimum in heater control. In that system, the outlet temperature controller directly actuated a valve in the fuel supply line. Fig. 2 illustrates a refinement in control; namely, the use of an additional flow controller in the fuel supply line. In this system, commonly referred to as a cascade control system, the set point of the flow controller is continuously and automatically adjusted by the temperature controller. The system, which is used widely in your industry, must have some economic justification. What is it?

Fuel supply pressures are seldom constant—there are frequent fluctuations which mean that the quantity of fuel or Btu's going through the control valve for a given valve opening is not constant. These fluctuations may be due to the effects of voltage variations on the pumps, fuel viscosity or density changes, or clogging tendencies of the burner ports.

Let us take the case of less fuel going through the valve for a given opening. Obviously, less fuel is going to cause a drop in heater temperature. This temperature change, as reflected at the heater outlet, may be several minutes developing. By the time this drop in temperature is detected at the outlet, the damage has been done, since the large heat capacity which works in our favor in maintaining the outlet temperature steady for awhile, even though fewer Btu's were being injected into the heater, will now work in our disfavor. It will now take a considerable time for the effects of a new valve setting to be felt at the heater outlet. Such conditions will cause a cycling about the control point, a condition which we have previously proved to be damaging to the process.

The additional flow meter has been added to compensate for these flow supply pressure variations and permits the temperature controller to do a much better job. In the case of gas fired heaters, where the Btu value of the gas changes with its density, this system also works out favorably. A heavier gas creates a greater differential when it flows through the orifice. The flow meter automatically cuts back the flow of the heavier gas, thus tending to let a gas of constant Btu value pass through the valve which, of course, contributes to stabilizing the heat input to the heater.

The need for accurate outlet temperature control already has been substantiated and it follows that, if the additional equipment just described is

required to make the temperature controller do a much more effective and satisfactory job, it also is economically justified.

How far is it economically sound to refine a control system? This question can be answered completely, of course, only when full and specific details of a given application are known, but some general commentary is in order.

Heater control systems aren't so complicated today as they were a few years ago. There was a time when derivative action in a controller on heater outlet temperature service could be justified. That need was due principally to weaknesses in the instruments themselves. Fortunately, today, improved thermocouple designs and the use of electronic balancing in potentiometers, have greatly decreased the lags which were present in measuring systems. Thus, more complex controller actions are no longer required to overcome measurement weaknesses. There are several entire refineries today where you will find absolutely no use of derivative action in controllers.

Some refineries have improved their heater control systems by using electric type flow meters on the charge stock and fuel lines. The close coupling of meters of this type with the orifice eliminates the need for seals and increases speed of response. In addition, such meters can be steam traced at much higher temperatures to permit the handling of viscous fuels. The volumetric displacement of the electric type meter is much less, also contributing to faster response.

A refinement in instrumentation often used where atomizing type burners are used on oil fired heaters is the proportioning of steam flow to oil flow. This can be accomplished by employing a regulating valve to maintain a definite differential between oil and steam pressure. The principal benefit to be gained from this arrangement is steam economy, which if calculated over the period of a month, can be appreciable.

No heater can be considered completely instrumented without the recording of several metal tube temperatures, bridgewall, and combustion zone temperatures. These points normally are recorded on a multi-point instrument. With the close personal attention of a trained fireman, why record such temperatures automatically?

One reason, of course, is that it is not uncommon today for one fireman to take care of three heaters. And, too, even a well-trained eye can not be compared with a thermocouple when it comes to measuring temperature. Thermocouples spotted on the tubes are quick to sense the hot tube, due either to coking or improper flame conditions in the heater. They are and have been responsible for keeping many a heater on stream, whereas if such observations were left entirely to a fireman, the chances for developing real difficulties would be much greater.

I have concentrated on heaters thus far, in that heater instrumentation in itself represents a trend in your industry. Much greater emphasis is now being given to proper heater instrumentation than ever before. For years, it appears that the fractionating tower received the greatest amount of attention, not only on the part of the contracting engineers and the instrument manufacturers, but also by the refiners themselves. The need for better and closer control on heaters has become more apparent as their design, with less heating space but greater velocities, has evolved.

Closely associated with heater instrumentation is combustion control and efficiency. Can you name an industry which consumes as much fuel as the petroleum industry and yet which, over-all, has paid less attention to combustion efficiency? Some interest has been shown in this subject during the past few years and this definitely can be counted as another trend. As the industry becomes more and more fuel conscious, undoubtedly more research into this application will be conducted.

Instruments Free Labor

Thus far, I have not said much as to how instruments free labor for other duties. Two interesting case histories will bring out this economic advantage.

One large refinery installed a de-ethanizer unit to further process one of the streams from an adjacent poly plant. The new de-ethanizer unit was put up about 30 feet from the poly plant and about 60 feet from a large fluid cat unit. The distances involved were just enough to make it inconven-

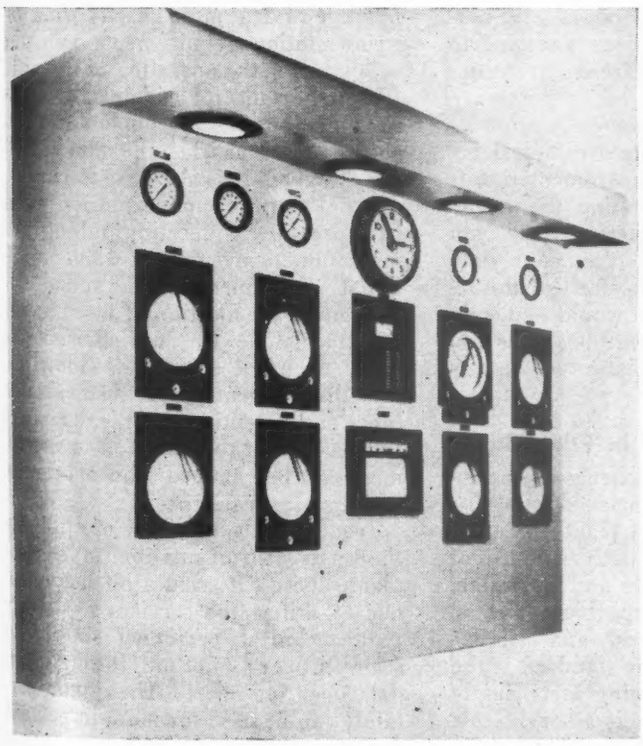


FIG. 3. Typical pre-wired, pre-piped, package control panel.

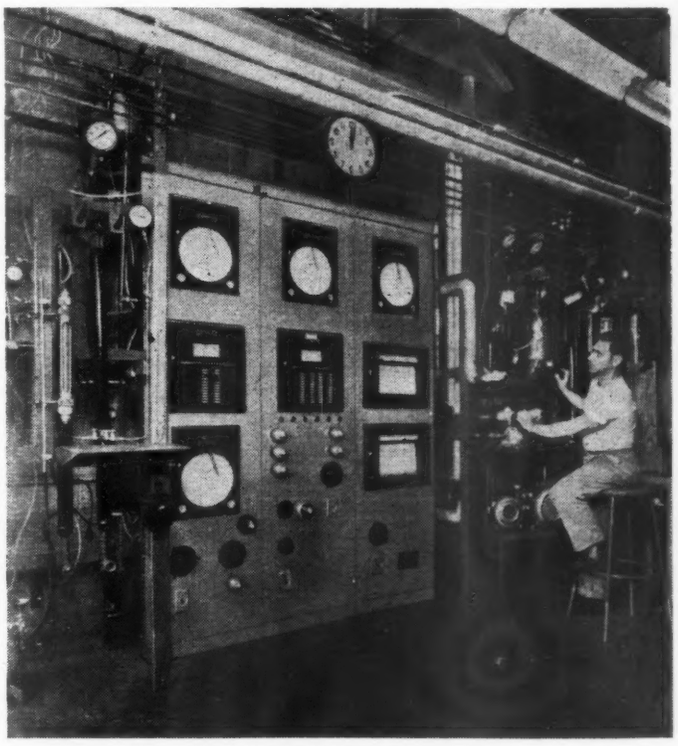
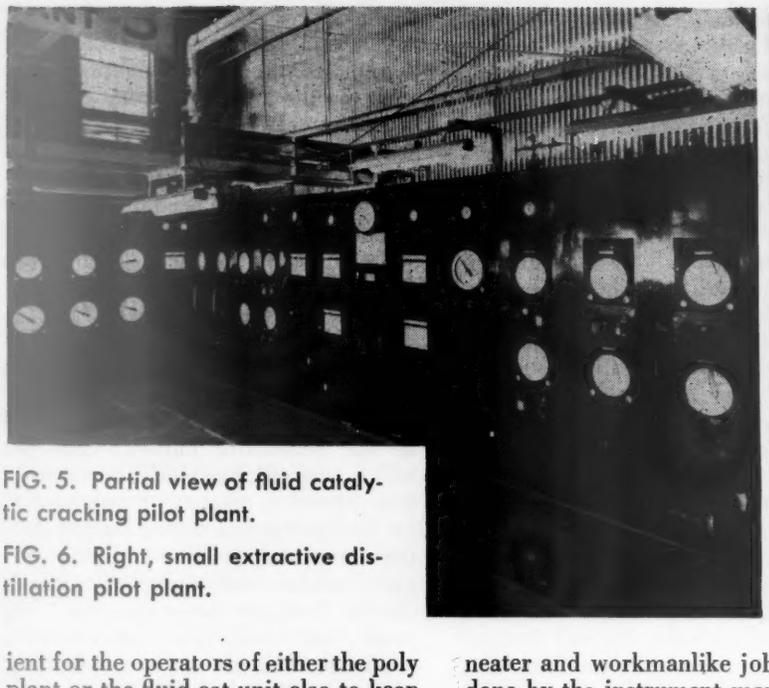


FIG. 4. Bench scale thermal cracking setup.



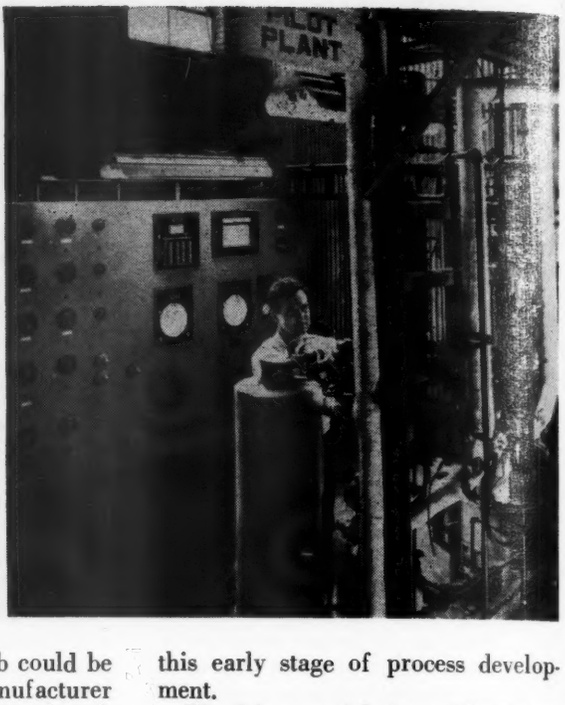


FIG. 5. Partial view of fluid catalytic cracking pilot plant.

FIG. 6. Right, small extractive distillation pilot plant.

ient for the operators of either the poly plant or the fluid cat unit also to keep close watch on the de-ethanizer. Originally, it was planned to install a panel with approximately ten instruments at the base of the de-ethanizer. Upon further study, however, it was decided to locally mount pneumatic transmitters on the de-ethanizer unit and place the instrument panelboard for this unit in the control house of the poly plant. In this manner, the operators of the poly plant could easily absorb the additional supervision of the de-ethanizer. Were it required for these operators to travel to an instrument board at the de-ethanizer unit proper, however, chances are that an additional operator would have been demanded, in that the philosophy at this particular refinery is that a minimum of one operator must go with each panelboard of appreciable size.

The extra investment in pneumatic transmitting and receiving equipment was a little over a thousand dollars. To operate the de-ethanizer unit, one man per shift, it was estimated that the total cost per year would be $20,000. This figure, of course, included wages for one man per shift, plus necessary funds for workmen's compensation, hospitalization, retirement plan, etc.

In this particular refinery, labor is paid close to $3.00 per hour. When requesting a quotation for instrumentation, they asked for figures on the instruments alone and also for a completely pre-wired and pre-piped instrument panel, packaged for ready installation upon receipt at the refinery. A panel of this type is illustrated in Fig. 3.

Their calculations indicated that a packaged panel was slightly more economical and, since this is a moderate size refinery, they felt that a much neater and workmanlike job could be done by the instrument manufacturer than by local labor. The use of such packaged panels is another trend today. In this case, the petroleum industry is following rather than leading. In the paper and textile industries during recent years, for example, these prefabricated panels have been very popular, but they are just beginning to take hold in the refineries.

In another refinery, a battery of desalters was added to treat the feed to a crude unit. By mounting the instruments required for desalter operation in the crude unit control house, the operators of the crude unit were quite able to absorb this additional supervision. Thus, the operators who normally would have been assigned to desalter duty were freed for duties elsewhere.

Oftentimes the economic value of instrument records is overlooked because this phase of instrumentation is somewhat less interesting than complicated control systems. Have you ever realized how helpless your yield department would be if all of the recording flow meters would suddenly cease operation? Please bear this factor in mind when later we discuss graphic panels.

More Instruments in Pilot Plants

Many more instruments of the industrial type are being used today for bench scale and pilot plant operation in the petroleum industry. The use of multi-point indicators and recorders, in place of the stem-type thermometers, dial pressure gauges, and similar equipment, previously standard in the pilot plant, is becoming increasingly popular. Shown here is a bench scale thermal cracking apparatus, Fig. 4. Note how instruments are stressed in this early stage of process development.

Fig. 5 is a partial view of the instrument board for a fluid catalytic cracking *pilot plant.* This panel, incorporating over thirty major temperature, pressure, flow, and liquid level recording and controlling instruments, almost belies the fact that this is a pilot plant.

Industrial type instruments aren't reserved for the large pilot plant, however. Shown in Fig. 6 is a comparatively small pilot unit in which extractive distillation studies are being carried out.

Since pilot plants are processes in an experimental stage, it usually is not possible to determine exactly what instrumentation requirements will develop during the operation of the unit. It is important, for example, to allow for numerous thermocouple and pressure connections when the pilot vessels are designed. It is also wise to run additional thermocouple extension wires and pressure connecting tubing for maximum convenience when additional instruments are added or changes in the location of instruments are made. Likewise, it is advisable to carry an extra supply of slidewires, pressure elements, flow meter range tubes and potentiometer range change spirals, so that the range of an instrument can be changed with maximum speed and convenience.

Insofar as the economy of applying thorough instrumentation to a pilot plant, doesn't it seem a bit incongruous to utilize the services of highly paid technical personnel simply to scamper over a pilot unit jotting down data on a log chart? These men certainly can be used for more important duties.

Part 2 will be published soon.

Survey of Pressure Type Thermometers

Various qualities of measuring elements are studied in detail to determine the kind best fitted for specified jobs.

G. L. FARRAR*

POSSIBLY the most important one variable that requires measurement and/or control in petroleum refining and natural gasoline operations is temperature. Most physical and chemical processes require close control of temperature if precise results are to be obtained. Thus the problem of temperature measurement and control should be examined critically in order to meet process requirements.

The first consideration in temperature measurement is the selection of the measuring element. The choice of the measuring element is based on a number of factors, such as ruggedness, dependability, accuracy, speed of response to a temperature change, cost, maintenance, etc. For some installations the pressure type thermometer fulfills the overall requirements better than any other type element. For this reason the purpose of the present article is to present some of the fundamental principles of the pressure type thermometer and to examine qualitatively the three types of pressure thermometer in light of the above considerations. The final choice will depend on a detailed examination of the measurement problem at hand.

In developing this subject, a description of the pressure type thermometer will be given first. Then the basic theory of the 3 types of pressure thermometer and the speeds of response of each type will be discussed. Some typical installation considerations will then be covered, and the discussion will be concluded with a qualitative comparison of pressure thermometers with other temperature measuring elements.

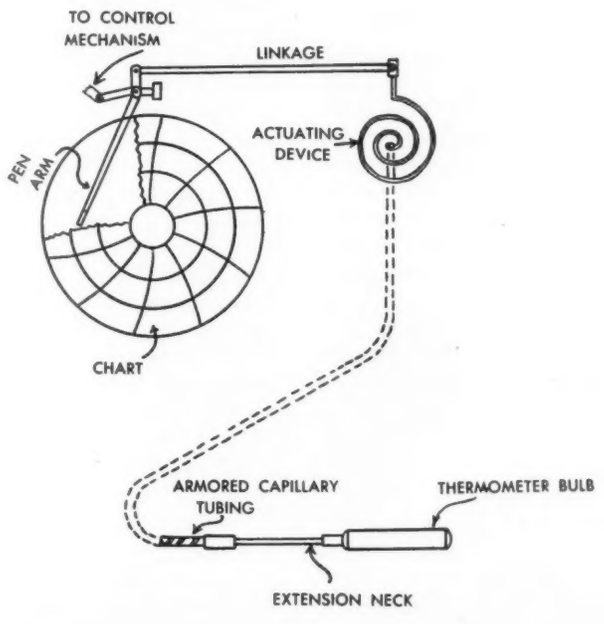
Basic Pressure Thermometer

The pressure type thermometer is made up of either 4 or 5 separate parts, depending on whether the instrument is indicating or recording. As shown in Fig. 1, these parts are (1) the pressure bulb, which is immersed in the fluid to be measured; (2) an armored capillary tube, which connects the bulb with the recorder; (3) an actuating device (spiral or similar mechanism) in the instrument to respond to changes in pressure; (4) a linkage to multiply the movement of the actuating spiral, and position a pointer or pen showing the measured temperature; and (5) a chart drive and holding mechanism, which revolves the chart at some constant speed. Obviously the chart mechanism is not required for an indicating element. In this case a fixed scale is built into the instrument case. The bulb, capillary tube, and actuating spiral are filled with the "filling fluid" which may be liquid and/or gas.

It is imperative that the bulb of the thermometer be so constructed that there is a rapid response to any difference in temperature between the bulb and that of the measured fluid. When a difference in temperature exists, due to a change in the fluid temperature, heat is transferred to or from the bulb and to or from the filling fluid. This flow of heat causes a temperature change in the bulb system, and a corresponding change in the pressure exerted by the filling fluid. The speed of response, then, will increase as the ratio of surface area to volume of the bulb is increased. Also the thermal conductivity of the bulb metal should be as high as possible, while the weight of metal in the bulb should be reduced as low as possible for withstanding system pressure safely.

The extension neck is made an integral part of the thermometer in order to protect the capillary at the point where it enters the bulb. Too, the extension neck may be bent to the de-

FIG. 1. Basic pressure thermometer.



*Assistant professor of chemical engineering, Texas A&M College, College Station, Texas.

EXCLUSIVE

sired angle for proper installation of the bulb. Another function of the extension neck is to permit adequate insulation of the process and proper immersion of the bulb at the same time.

The capillary tubing used to transmit the thermometer pressure to the actuating device is of very small diameter, and in a large number of cases, the tube wall is very thin. This tubing is easily collapsed or otherwise damaged. In most cases the tubing is protected by flexible outer tubing, made of such materials as lead, copper, molded rubber, bronze, ambrac, or stainless steel. The maximum allowable length for the capillary tubing will depend on the type filling fluid and the specific problem at hand. In general, however, the maximum allowable length will be some 50 to 200 ft.

The actuating device used with a given pressure thermometer will depend to a large extent on the pressure limits within the filled system, corresponding to the desired temperature range. For low to moderate pressures a diaphragm or bellows may be used, while the spiral is used in the higher pressure ranges. The bourdon tube is rarely used, since very little movement occurs in this element. As noted in Fig. 1, a linkage is used to magnify the movement of the actuating device, and to permit easy adjustments during calibration or recalibration. For a recording thermometer, a chart holder and drive are required. The pen thus makes a continuous record on the chart as the chart revolves. Most chart drives are set to make one revolution each 24 hr; however, it is possible to obtain drives operating at almost any given speed.

Basic Theory of Operation

There are 3 classifications of pressure thermometers: (1) Gas-filled thermometers, in which the filling fluid is entirely gaseous throughout the designed range of operation; (2) vapor pressure thermometers, in which both liquid and vapor exist in equilibrium throughout the design range of operation; and (3) liquid-filled thermometers, in which the filled system is liquid-full. Although the general theory is the same for these 3 types of pressure thermometers, there are certain points of interest that exist. Consequently, each type will be considered separately.

The vapor and liquid in a vapor pressure thermometer are in equilibrium at the vapor-liquid interface throughout the design temperature range. As temperature is increased, liquid vaporizes in the filled system, thus increasing the pressure in the system. Liquid continues to vaporize until the vapor and liquid are again in equilibrium. The pressure at which a liquid and its vapor are in equilibrium at a given temperature is known as the vapor pressure of that particular material at that temperature. As temperature increases, the vapor pressure increases almost exponentially.

It has been found that variation of vapor pressure with temperature can be plotted as a straight line, As ordinate, or on the Y-axis, the logarithm of vapor pressure is plotted. This may either be $\log_e$ or $\log_{10}$. If prepared log paper is used, the values are automatically recorded as $\log_{10}$. To define the abscissa, or X-axis, the temperature is first converted to absolute temperature. Then the reciprocal of this absolute temperature $\frac{1}{T}$ is used as the abscissa. Thus the logarithm of the absolute vapor pressure is plotted against the reciprocal of the absolute temperature. Vapor pressure data must be obtained from one of the standard general reference sources on physical properties. This relationship is illustrated.

As the temperature-pressure relationship is defined at the liquid-vapor interface, a difference between the temperature of the bulb and temperature of the capillary tubing and actuating device will cause no error in reading the true temperature. As will be shown later, this point is cause for error in either the gas-filled or the liquid-filled thermometers. Due to the characteristics of the vapor pressure thermometer the bulb must be large enough to contain all the liquid in the system. Then if the bulb is hotter than the tubing and actuating device, the tubing and actuating device will be liquid full and some of the liquid will be in the bulb. If the bulb is colder than the rest of the filled system, all the liquid will be in the bulb. Thus the vapor-liquid interface will always be in the bulb, which of course registers the temperature of the measured fluid. In making this point it is assumed that bulb and actuating device are on the same level. Otherwise the liquid will always drain to the low point in the system, even though it may again be vaporized at that point. It should be pointed out here that the vertical distance between the bulb and the actuating device will affect the calibration of the thermometer, and this distance must be specified when ordering this instrument.

If the vapor pressure thermometer is used at bulb temperatures close to the surrounding temperature, there is a possibility that the bulb temperature will fluctuate between values higher and lower than the surrounding temperature. Thus, from the foregoing discussion, it is seen that as the bulb temperature changes from the colder temperature to the hotter, liquid will be vaporized out of the bulb into the tubing and actuating device until this portion of the system is liquid full. Likewise, for the opposite change, the liquid in the tubing and actuating device will be vaporized out and condense in the bulb. This phenomenon is known as the "cross ambient effect". It is obvious that this type of change takes some time and that during that time, the thermometer will not be reading accurately. In some processes it is possible that this so-called "lag time" cannot be permitted. In this case, the vapor pressure thermometer would not be used.

As may be readily seen, the liquid used in the vapor pressure thermometer will depend on the temperature range of the thermometer. If a high temperature is to be indicated, the liquid will be one that boils at a fairly high temperature. Thus, the developed pressure will not be excessive. Too, it must be borne in mind that once the critical temperature is reached, it is not possible to liquefy a substance, regardless of pressure. Likewise, if the temperature range is to be at low values of temperature the liquid used must boil at low temperatures so that sufficient working pressure will be developed.

As shown in Fig. 2, the plot of vapor pressure as a function of temperature is not a linear function, but approaches an exponential function. This fact must be borne in mind when considering the scale or chart for a vapor pressure thermometer. As temperature increases, the graduations on the chart must be progressively wider. If the desired temperature is in the upper range of the chart, it is possible to read the actual temperature more accurately than it could be read with a linear scale of the same range. If the temperature is in the lower range of the chart the reading of the actual temperature will be less accurate than with a linear chart of the same range.

When used under the proper conditions the gas-filled thermometer is very accurate, possibly more accurate than the vapor pressure or liquid-filled thermometers. Most accuracy is obtained in the regions where the filling gas most closely follows the perfect gas law, as the gas-filled thermometer is based on Charles Law. This Law states that the absolute pressure of a perfect gas at constant volume varies directly with the absolute temperature. A plot of pressure as a function of temperature will then be a straight

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NEW DEPENDABILITY, ECONOMY, CONVENIENCE IN MECHANICAL TIMING

STANDARD TYPE
For Replacement Service

Furnished with Adaptors to Fit Practically Any Instrument Case. Turrets Give Up To 11 Rotation Speeds

You can save money on inventory by standardizing on Rockwell chart drives for all your instruments. You need stock only two basic Rockwell models plus a representative selection of inexpensive adaptors and turret speed changers. The adaptors will correctly position the drive in any instrument while the turrets will provide up to 11 different rotation speeds on the same drive.

STANDARD DRIVE FEATURES

Dust proof, moisture proof case. Heavier mainspring and winding stem minimize principal causes of failure. Fitted with oil-sealed bearings, a single winding stem. Two basic models—8-day wind and 31-day wind. Turrets provide selection up to 11 speeds on one drive.

MIDGET DRIVE
obtainable on specification in most instruments

You can specify Rockwell Midget drives in instruments made by any manufacturer. The small size of the Midget allows more room for the other controls within the case and makes all the component parts readily accessible for service. Midget drives snap into a mounting ring which may be positioned on bosses or on adaptors to fit into any instrument case. In no other drive will be found the Rockwell combination of size, versatility, and high quality.

MIDGET DRIVE FEATURES

Made in three parts: the case, including mainspring and gears, a detachable escapement sealed in transparent plastic and a mounting ring. Winds through the chart arbor. Two models—8-day wind, 24-hour rotation and 24-hour wind, 24-hour rotation. Patented turret converters which snap on the main arbor provide a selection of 11 speeds on 8-day model.

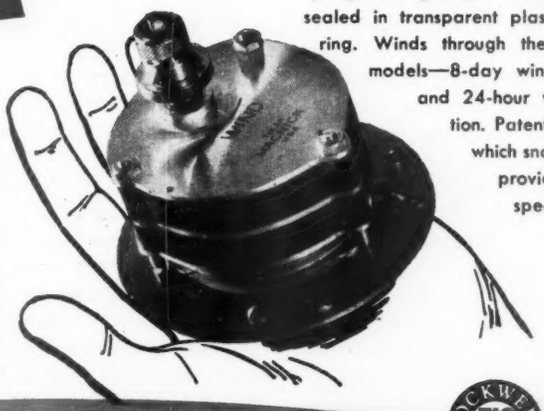

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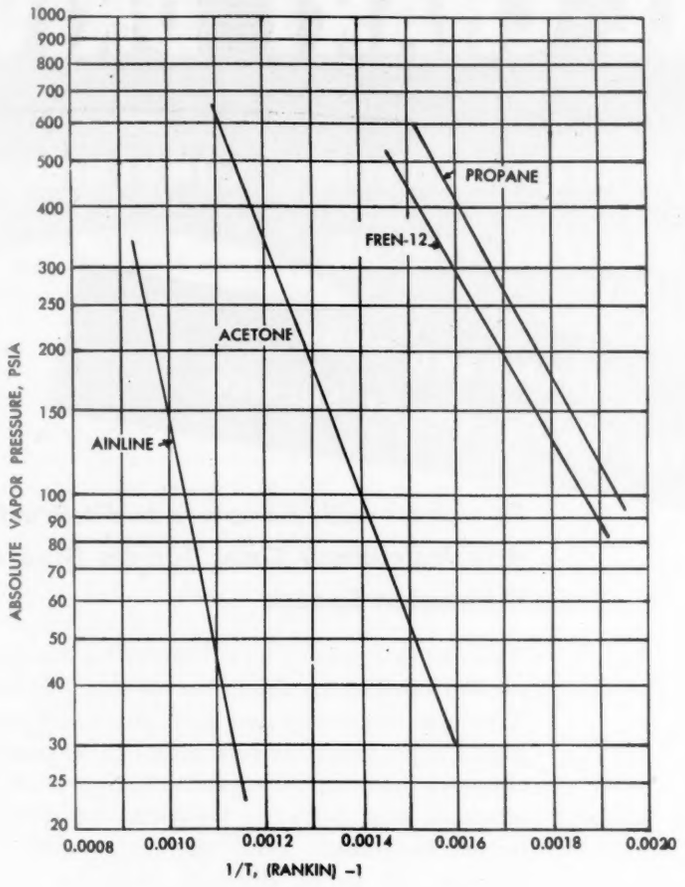
FIG. 2. Vapor pressure variation with temperature.



line on rectangular coordinate paper. It follows that the scale or chart for the gas-filled thermometer will have equal graduations.

It is not possible, however, to find a gas that will follow the perfect gas law absolutely. The deviations can be calculated and a correction applied to the scale reading if desired. This correction is usually not necessary for commercial thermometers if the proper gas is used. The filling gas should be chosen so that the temperature range for the thermometer is well above the critical temperature of the gas. Initial pressures are usually in the range, 150 to 500 psia. The gases commercially available that most nearly meet the desired specifications are nitrogen, hydrogen, carbon dioxide, oxygen, and air. Hydrogen has the advantage of having a very low critical temperature, but the disadvantage of being combustible, hard to contain in a pressure tight system, and harder to obtain in the pure form than some of the others. Nitrogen is used in most gas-filled thermometers, since its advantages are only slightly less than those of hydrogen, and it is easily obtained in sufficiently pure form at low cost. It will not react chemically or physically with the containing metal at high temperatures, and it is easily sealed and contained in the filled system.

It is readily apparent that the capillary tubing and actuating device are rarely at the same temperature as the bulb immersed in the measured fluid. The pressure developed will not be equal to the pressure that would be developed if all the system were at constant temperature. The pressure will then depend on the values for the different temperatures and the volume of gas at each temperature. In order to minimize the error introduced by this phenomenon, the volume of the bulb should be maintained high in relation to the volume of the rest of the filled system. This method is the simplest way to accomplish this so-called "ambient compensation", and is satisfactory in the majority of installations. Additional correction may be made by including a bimetallic strip as part of the linkage between the actuating device and the pen or pointer arm. A third method of accomplishing this correction is employed where highest accuracy is desired. This method employs the use of another actuating device coupled in opposition to the primary actuating device. If the tubing for the second actuating device is run alongside the tubing for the primary actuating device, tubing errors, as well as actuating device errors, are compensated.

In general the volume of bulb should be about 10 times as much as the volume of the tubing plus the volume of the actuating device. The maximum tubing length is usually less than 200 ft, however, this length can be extended somewhat if a larger bulb is used.

The liquid-filled thermometer, like the gas-filled thermometer, depends on the expansion of a fluid as a means for developing pressure. A liquid to be used in a liquid-filled thermometer should have several characteristics. It should be practically incompressible, its vapor pressure must be negligible in the desired temperature range, and its coefficient of cubical expansion should be high. The cubical expansion principle is shown in Equation 1.

$$(1)\quad V_t = V_o\,(1 + k\,\Delta t)$$

V_t = volume of liquid at the final temperature

V_o = volume of liquid at the initial temperature

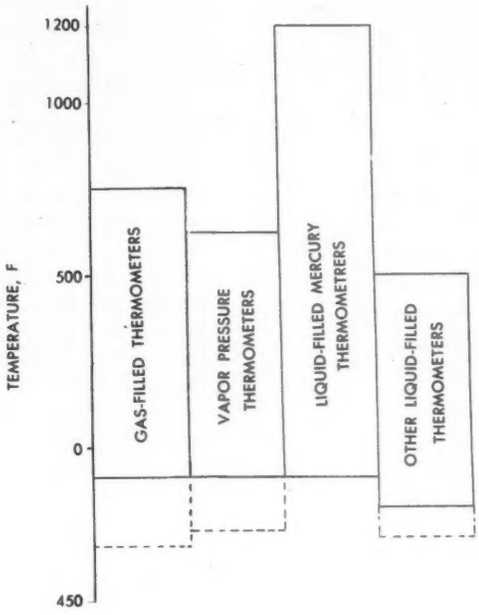
k = average coefficient of expansion over the temperature change of the thermometer, F^{-1}

Δt = temperature difference, final temperature minus the initial temperature

It may be seen from Equation 1 that the volume of the liquid varies directly with temperature, and as a result of this volume change, the pressure also is increased. The chart or scale graduations will then be approximately linear. As pressures within the filled system are rather high for this type of thermometer, the bulb location rarely has appreciable effect on the final indicated temperature.

The most commonly used liquid in the liquid-filled thermometer is mercury. Materials must be used which will not be amalgamated by mercury, but otherwise there are few disadvantages to the use of this material. Too, the above-mentioned desirable characteristics are to be found in this liquid. The problem of ambient-temperature compensation for that portion of the

FIG. 3. Temperature ranges of pressure thermometers.



filled system at a temperature different from the bulb temperature is very similar to that of the gas-filled thermometer, hence, no additional treatment will be given here.

The various types of pressure thermometers are suitable for rather wide ranges of temperature as shown in Fig. 3. As may be seen from this plot, there is considerable overlap in the intermediate ranges. In general the gas filled thermometer finds wider usage at very low temperatures than the other types. The vapor pressure and liquid-filled thermometers other than mercury are also used at rather low temperatures. It is difficult to find liquids of the proper phase characteristics at extremely low temperatures. All types may be used in the approximate temperature range, — 50 to 500 F. In this range choice of element must be based on the characteristics of a given system. Vapor pressure thermometers are seldom used above 500 to 600 F, while gas-filled thermometers are not generally used above 750 F. The liquid-filled mercury thermometer may be used up to about 1200 F, although the usual range terminates somewhat below this temperature. For temperatures higher than this value, thermocouples, resistance units, or pyrometers are usually used.

Speed of Response

The response speed of a thermometer depends on the "thermometric time lag" of the element. This time lag may be defined informally as the time required for a thermometer to indicate the true temperature of a system after a change in system temperature has occurred. It is not possible to assign a given value for response speed or a value for thermometric lag to a given thermometer, since these quantities depend on several factors, most of which may vary considerably depending on the actual installation.

The meaning of thermometric lag and its characteristic behavior may best be described by Newton's Law of Cooling. This law states that the rate of temperature change between two points is proportional to the temperature difference between the two points. Stated mathematically,

$$(2)\quad d\theta/dt = \frac{1}{L}(u - \theta)$$

$d\theta/dt$ = rate of change of temperature of one body

θ = temperature of that one particular body

u = temperature of the other body

L = lag coefficient of the body defined by temperature, θ

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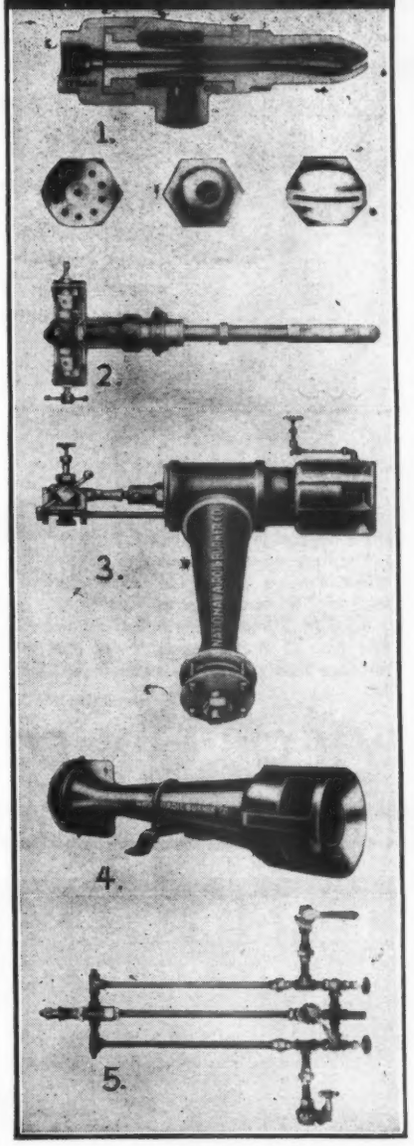

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In applying this equation, θ will be taken as the temperature indicated by the thermometer, while u will be taken as the temperature of the measured fluid. In this manner, the lag coefficient, L, will be defined in terms of the thermometer and may be used for that thermometer in other applications.

The standard procedure for testing response speeds is to immerse the thermometer bulb in a constant temperature bath until no change in temperature is noted on the scale or chart. Then the bulb is quickly removed and immersed in another constant temperature bath. The response curve is then plotted as a function of time. Equation 2 will now be examined in light of this procedure. The temperature, u, is now a constant temperature, and the variables are separable.

$$\frac{d\theta}{u - \theta} = \frac{dt}{L}$$

Integrating,

$$\int_0^1 \frac{d\theta}{u - \theta} = \int_0^t \frac{dt}{L} \; ; \ln$$

$$\left(\frac{u - \theta}{u}\right) = -\frac{t}{L}$$

Note that the limits taken for integration of θ are between 0 and 1. This means that the calculated or observed θ will be in terms of the fraction of temperature change indicated by the thermometer. Also note that the temperature u automatically becomes equal to 1. This is true since the final value of θ will necessarily be equal to u, and in this case this value is 1. Substituting the value 1 for u, the final equation becomes,

$$\ln (1 - \theta) = -\frac{t}{L}$$

Or in exponential form,

$$(3) \quad \theta = 1 - e^{-t/L}$$

It will be noted that this equation is dimensionless, and that the lag coefficient must have the same dimensions as t, or, time units. This also follows in that lag is by its definition a time quantity. To obtain a numerical value for L, set $t = L$ and solve for θ at that given time.

$$\theta = 1 - e^{-1} = 1 - 0.368 = 0.632$$

It is seen that 63.2 per cent of the total change in θ is accomplished at a time equal to the lag coefficient. The lag coefficient may be observed as the time required for 63.2 per cent of the temperature change to occur. Using this value of L in Equation 3 defines the theoretical response for any given thermometer. The calculated curve for a thermometer having a lag coefficient of 6 sec is shown in Fig. 4, as the dotted curve. It may be seen from this figure that the change is substantially complete after about 30 sec. It may be noted in passing that the change will never be 100 per cent complete, although this value may be very closely approached as time, t, becomes very large.

The Brown Instrument Company in Bulletin No. 60-1, entitled, "Response Speeds of Pressure Type Thermometers", describes a number of tests made on pressure thermometers made on production orders. The procedure used to test these elements was that described above using two constant temperature baths. Several tests were made on each type of pressure thermometer, and the results shown. It was found that with little error a composite response curve could be constructed from the individual curves for each type. The composite curve obtained is also shown in Fig. 4, and it is seen that the calculated curve compares very favorably with the actual. The Brown Instrument Company recommends that values taken from this curve be considered accurate to $\pm$ 10 per cent.

It should be pointed out that the above-mentioned response curves are applicable only for bare thermometer bulbs. If it is found necessary to use a protecting well to house the bulb, the response speed will be reduced, and a different type curve will be obtained. Due to the time required for heat transfer through the well and to the bulb, the initial rate of change will be slow and increase to a maximum as time elapses. This effect is shown in Fig. 5. Note that the response curve for the bare bulb shows the initial rate of change to be the greatest. An examination of Equation 3 will show the same thing, in that rate of temperature change is proportional to the temperature difference. Of course, this difference is being constantly reduced.

Response speeds for temperature elements in a fluid of changing temperature must be evaluated in terms of the manner in which the temperature is changing. This may be done in terms of the lag coefficient as described above. At any rate, further discussion of this point is beyond the scope of this paper.

Installation Considerations

It is not the purpose of this discussion, nor is the space available, to present detailed directions for the installation and operation of pressure type thermometers. Rather, it is the pur-

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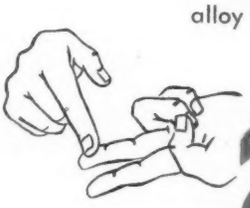

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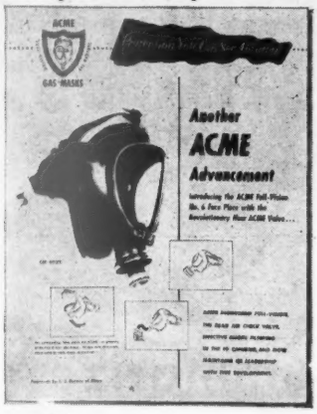

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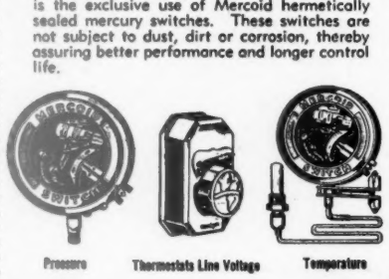

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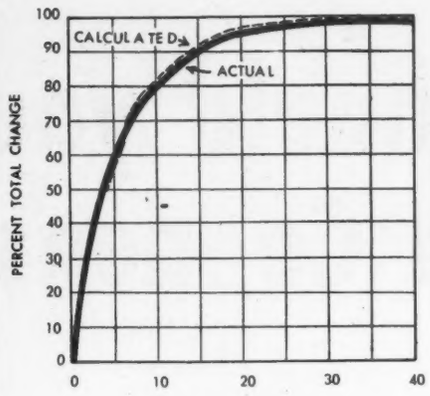

FIG. 4. Response of bare pressure thermometer.

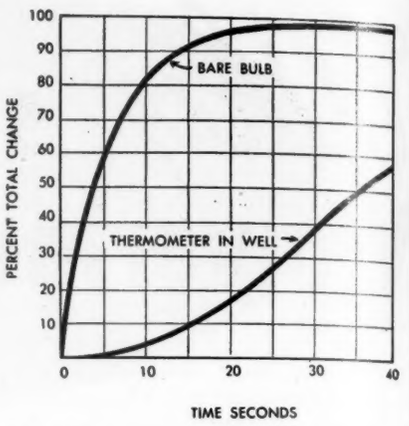

FIG. 5. Comparative responses of pressure thermometers.

pose to point out a few general principles that are easily applied to a given installation. These principles are based on heat transfer and bulb location considerations.

The problem of heat transfer between the measured fluid, the thermometer bulb, and the walls of the pipe or vessel containing the fluid is rather complex. The results of detailed and exhaustive study, however, show that (1) the bulb should be completely immersed in the measured fluid. (2) If the temperature of the measured fluid is significantly different from the surrounding (ambient) temperature, the thermometer should have a long extension neck, and the wall of the vessel should be well insulated at the point of installation of the thermometer. (3) The bulb should be located in the fluid at a point such that the most representative temperature is being indicated or recorded (this point is difficult, and at times, impossible, to determine). (4) The measurement of relatively high gas temperatures is very difficult. Refinements such as radiation shields, constrictions in the pipe or vessel to increase the gas velocity past the thermometer, etc. are employed. For rather complete treatment of this subject the reader is referred to Dahl.[1] (5) Where considerable variation in temperature is expected throughout the measured fluid, "averaging bulbs" may be used. These are long bulbs that extend throughout a representative section in the measured fluid. (6) If very rapid response is not of prime importance, a thermometer well should usually be used. This provides added strength in the case of a pressure installation and permits the removal of the element for inspection and repair without the necessity of process shutdown.

[1]Dahl, Andrew I., "Measurement of High Temperatures in Gas Streams," presented at the Fourth Annual Symposium on "Instrumentation for the Process Industries," Texas A&M College, October 12-14, 1949.

☆ ☆ ☆

Oil industry investments for expansion during 1949 boosted the existing refining capacity of the United States to a new high of 6,550,000 barrels per day, up 73,000 barrels per day from the capacity available at the start of the year.

Comparisons With Other Elements

Possibly the greatest advantage of the pressure type thermometer is its low operating cost (including initial cost, maintenance, and expected life). The accuracy of this type element is generally not as good as an electric element such as a thermocouple or resistance unit. The vapor pressure thermometer perhaps finds more application than either the gas-filled or the liquid-filled thermometer, due to its reasonable cost and ease of repair. As already pointed out, this element should not be used in the neighborhood of the ambient temperature. Fuller[1] points out the general comparison between electrical, pneumatic, and filled elements. His results are summarized in Table 1.

TABLE 1. General considerations for choice between pressure, pneumatic and electrical thermometers.

Situation	More suited	Less suited
Long distance between bulb and instrument	Electrical and pneumatic	Pressure
Sensitivity need for control-ability	Electrical	Pressure
Over-all dependability	Pressure	Electrical and pneumatic
Damage likely to tubing	Electrical and pneumatic	Pressure
Accuracy of readings needed	Electrical	Pressure
Explosion hazard exists	Pneumatic	Pressure

[1]Fuller, D. H., "The Measurement and Control of Temperature," Presented at the Fourth Annual Symposium on "Instrumentation for the Process Industries," Texas A&M College, October 12-14, 1949.

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FIG. 1. General Electric gas-turbine-electric locomotive on the test track.

GAS TURBINES*

Resume of recent advances in this interesting field of power production.

BRUCE O. BUCKLAND†

THE General Electric Company gas turbine division in Schenectady, New York has built four gas-turbine plants. Three have been shipped from the factory and one is now on factory test. Three of the plants are designed for power generation and one is primarily for locomotive application. Three of the plants are designed to burn Bunker C fuel or any lighter oil, and one is designed to burn gas.

This paper describes the progress of these plants, gives the heat consumption performance, presents some of their uses and describes the fuels that have been used.

Locomotive Plant

The first plant to be shipped was designed in 1946 and 1947. It has been rather completely described and reported on elsewhere, (1), (2), (3), and (4). It is a 4800-hp simple-cycle plant designed for locomotive service and other suitable applications. It has been operated approximately 2600 hours, 700 of which were on test at the factory and 1900 of which were in the chassis of a locomotive. During this time it has burned approximately 700,000 gallons of Bunker C fuel and 300,000 gallons of diesel oil. The locomotive has traveled approximately 27,000 miles. Fig. 1 is a photograph of the locomotive described by Morey and Williamson (5) in which this gas turbine plant is operating.

Power Generation Plants

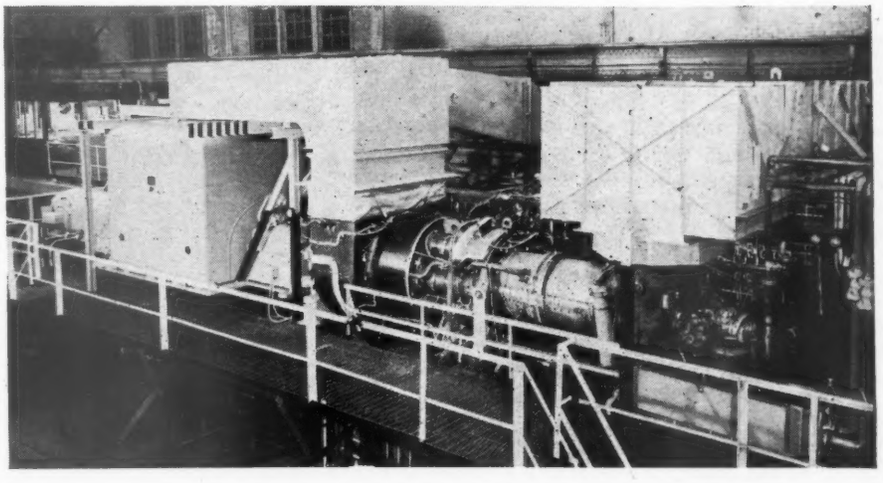
The second gas turbine plant was shipped from the Schenectady factory in April 1949. It is a simple-cycle gas turbine essentially like the locomotive but designed to burn natural gas and arranged to drive a 4000 kw, 0.8 pf generator through a reduction gear. It went into service in July 1949 in the Huey station of the Oklahoma Gas and Electric Company. Blake and Tumy have described it and the power-station factors associated with its application (6) and they have also reported on the results of its operation (7). Fig. 2 is a view of the complete plant on factory test in Schenectady and Fig. 3 is a photograph of the plant installed in the Huey station. It was tested on diesel oil at the factory as insufficient gas was available there for operation.

This plant, up until the time of disassembly for inspection in February 1950, had operated a total of 3912 hr at an average load of 3950 kw, which corresponds to a total generation of 15,500,000 kw hours. The inspection revealed that the plant was in good condition, so that it was reassembled with the original parts including the combustion chamber liners, which are expected to be the shortest lived parts of the plant.

Fig. 4 shows the guaranteed heat consumption of the plant. The actual performance thus far has been somewhat better than this.

The third gas-turbine plant to be built is not yet shipped. It is a 5000 kw, two-turbine, two-compressor intercooled plant with a regenerator, and therefore, is both more efficient

FIG. 2. Gas-turbine-generator 3500-kw set for Oklahoma Gas and Electric Company on the factory test stand in Schenectady.



*Presented at the 38th annual meeting of The Western Petroleum Refiners Association, San Antonio, Texas, March 27-29, 1950, under the title, "Four Gas Turbine Plants."

†Gas Turbine Engineering Division, General Electric Company, Schenectady, New York.

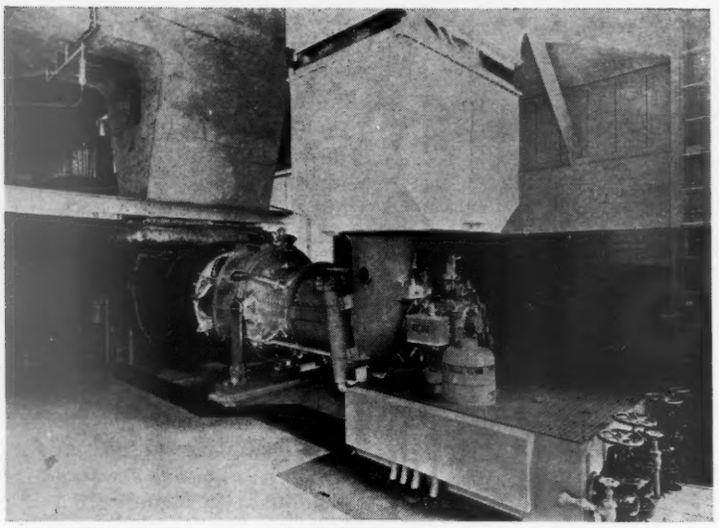


FIG 3. Gas-turbine-generator 3500-kw set at Arthur S. Huey Station of the Oklahoma Gas and Electric Company.

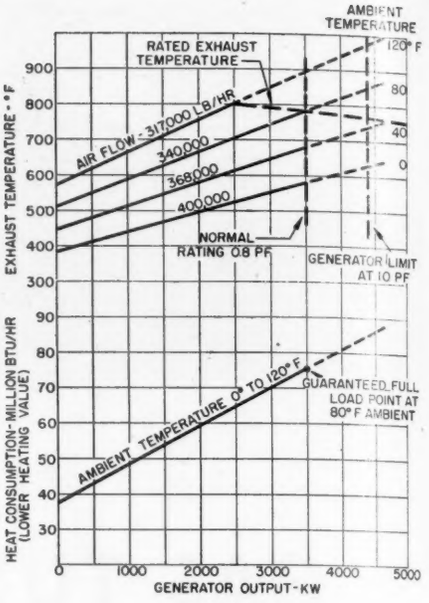


FIG. 4. Heat consumption and capability of 3500-kw gas-turbine-generator set.

and more complicated than the locomotive type plants. It was designed in 1946 and 1947, described by Howard and Walker (8), and went on factory test in October 1949. To date it has operated approximately 230 hours with generally satisfactory results. Fig. 5 is a photograph of the plant on factory test and Fig. 6 is a drawing to scale of a possible arrangement in a power station. Fig. 7 shows the guaranteed heat consumption of the 5000-kw plant.

The fourth gas turbine to be built is an oil-burning power-generation plant for a New England utility. It was shipped in February 1950, and is now being installed. The operating time is only 85 hours or so of running during the factory test. It is a simple-cycle locomotive type plant like the Oklahoma Gas and Electric unit except that it burns oil. Both this and the Oklahoma turbine are started by means of an 1800 rpm induction motor geared to an automatic jaw clutch that disengages and stops the motor after the plant is started. The clutch drives the set through the exciter by engaging with a cooperating part on the end of the exciter shaft. Fig. 8, which is a view of this plant on test at the factory, shows the starter and exciter.

Fig. 9 shows the control panel supplied with the unit, by means of which it is automatically fired and brought to synchronizing speed.

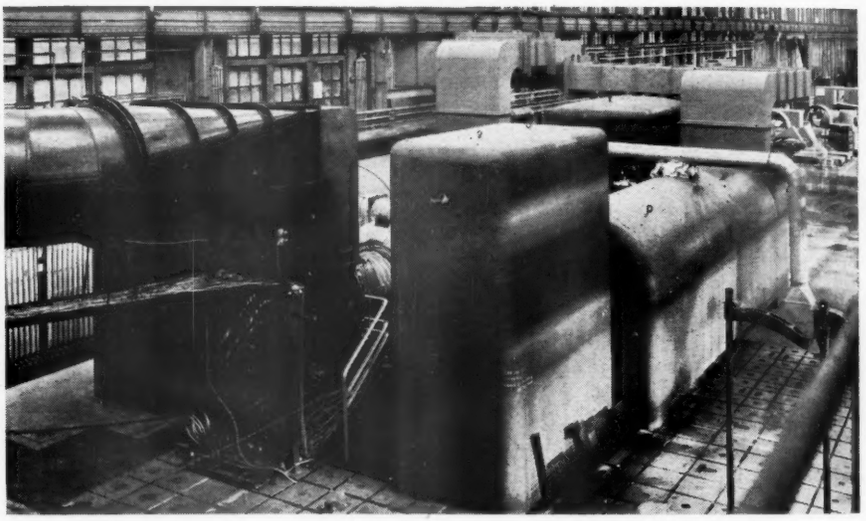


FIG. 5. General Electric 5000-kw gas-turbine-generator set on factory test stand at Schenectady.

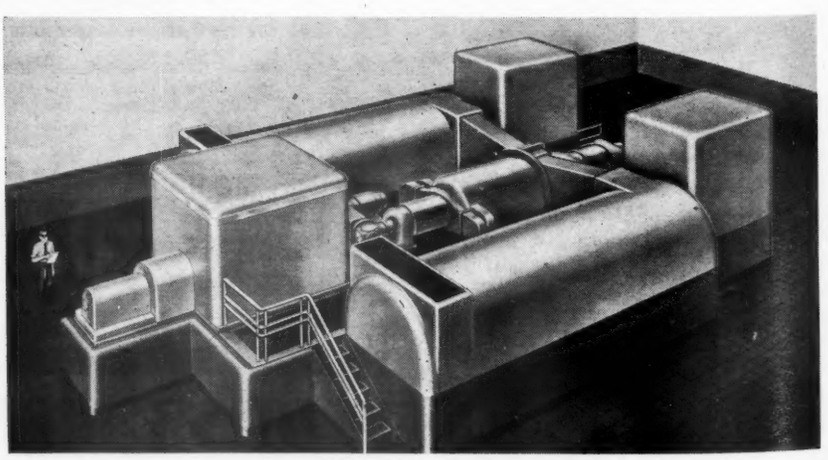


FIG. 6. Proposed arrangement of General Electric 5000-kw gas-turbine-generator set in a power station.

Applications

Applications of these plants has been described by B. G. Hatch (9).

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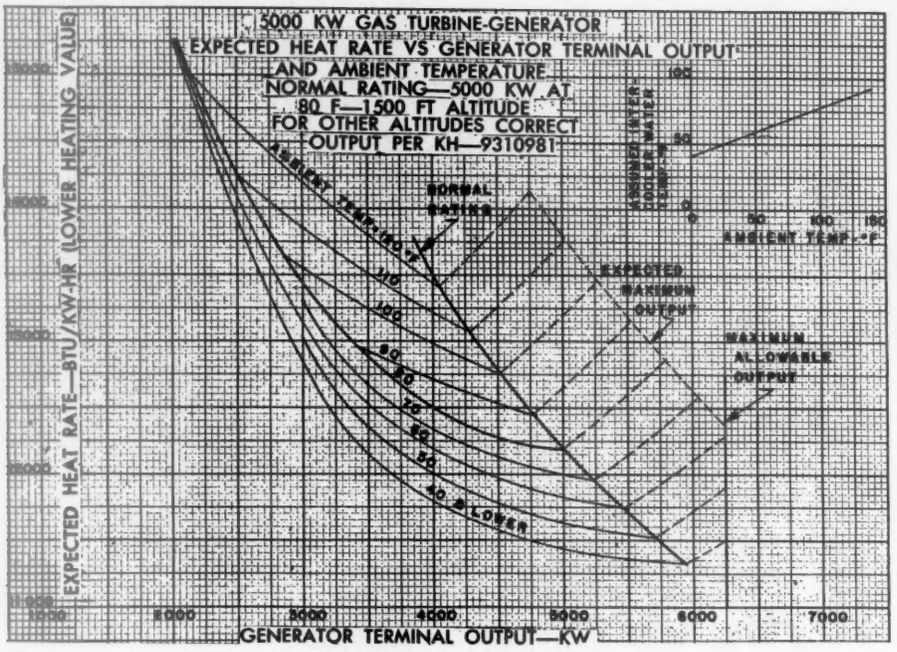

FIG. 7. Heat consumption and capability of 5000-kw gas-turbine-generator set.

In general, their features are:

1. Very low water requirements.
2. Compactness, small weight, and simple foundation requirements.
3. A complete package plant, with fuel supplied at the inlet and power produced at the generator terminals.
4. Automatic control of starting and stopping with consequent small attendance requirements.

More specifically, they can be useful for the following applications:

1. As a base-load unit for small systems on which 3500 to 5000 kw capacity is an economical increment.
2. As a power supplement and voltage stabilizer at the end of transmission lines and loops.
3. As a stand-by or peak-load plant where quick starting is desirable.
4. As a power supplement and heat-cycle improver in existing central station or industrial plants.
5. As a portable and emergency-use plant.
6. As a mechanical drive unit for compressors, pumps, or other similar machines.

Fuels

Natural Gas. The experience on the gas-burning plant thus far has shown that natural gas is a most convenient fuel. It is easy to handle and control and needs no atomizing nozzle or high pressure atomizing air as is required by residual oil. Fig. 10 shows two of the simple gas nozzles used in the combustion chambers. The filtering is simple and only a small screen filter need be used. The slight amount of brown dust carried by the gas seems to cause no trouble and the screen filter needs cleaning only every 3000 or 4000 hours. The radiation to the combustion-chamber liner is only a little less than with residual oil but the severity of the service of the liner is much less.

Many development tests have been made on a single-burner combustion stand using propane diluted with air to get heating values corresponding to that of natural gas and below. Heating values as low as 800 Btu per cubic foot were tested. Similar tests have been made with propane and nitrogen mixtures. The tests show that, with the proper gas nozzle design, a combustion chamber suitable for operation with oil will be suitable for operation with gas of these heating values also. Plans have been made to extend these tests to heating values of 90 or 100 Btu per cubic foot and with other gases, e.g., carbon monoxide.

Diesel Oil. As described elsewhere (1), (2), and (8), the oil-burning plants start and stop on diesel fuel. During about the first 200 hours of operation on the factory test of the locomotive unit, diesel fuel was used. Diesel oil was also used during the early runs on the locomotive in order to by-pass the problems of fuel heating and filtering. These two periods of diesel oil operation, plus the starting and stopping, account for a total of approximately 300,000 gal of this fuel used on the locomotive unit.

Residual Oils. The 706,000 gal of residual oil burned by the locomotive plant can be classified in accordance with the locality in which it was purchased as follows:

Location	*Gallons*
Schenectady	230,000
In and around Erie, Pa.	190,000
On UPRR—Los Angeles to Las Vegas and Salt Lake	286,000

The properties of the Schenectady residuals have been described elsewhere, (4), and no further description is necessary except to correct an error in the per cent ash constituents in Table 4 of this reference. The values reported there are, in all likelihood, considerably too high. They were obtained by following, as closely as could be interpreted, the ash determination method as specified by ASTM 482-46. Subsequent work showed that the ash-content values thus deter-

FIG. 8. Gas-turbine-generator 3500-kw set showing the starter, exciter, and generator.

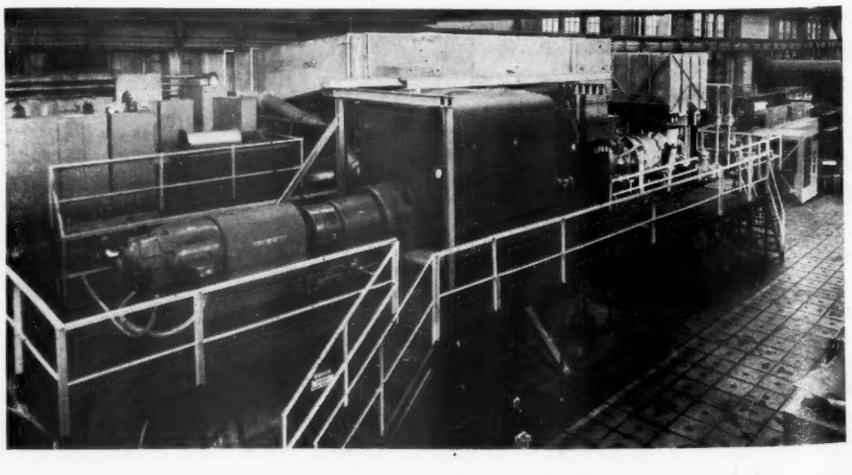

FIG. 9. Control panel for automatic starting and firing a 3500-kw gas-turbine-generator set.

FIG. 11. Oil ash deposit formed on the second stage nozzle of a gas turbine in 1200 hr of operation.

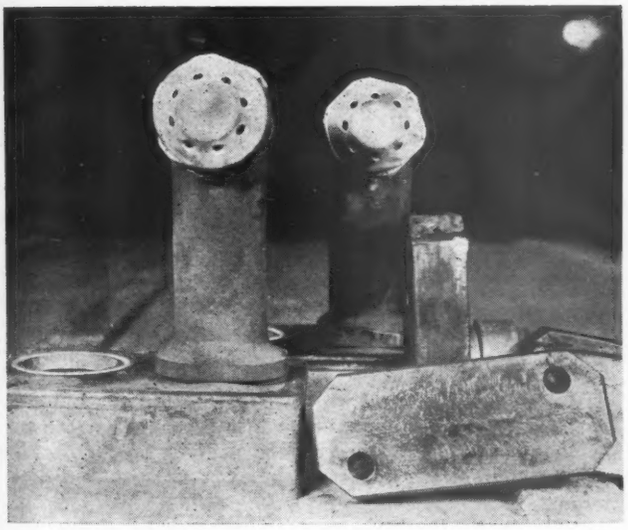

FIG. 10. Fuel nozzles used in a 3500-kw gas-burning gas-turbine-generator set.

FIG. 12. Oil ash deposit formed on the second stage bucket of a gas turbine in 1200 hr of operation.

mined were not repeatable, apparently because the sample heating time and heating means were not sufficiently well defined or duplicable. At the suggestion of an oil supplier (10) the method was modified to include a heating of the samples for one hour in a muffle furnace held at 620 C. Since this modification the results have been repeatable and the ash values reported here are measured in this way. Unfortunately, none of the samples reported in (4) were available for reruns after the foregoing experience but it is believed that the ash values reported there are about 8 to 10-fold too high.

The range of properties, and the average, for the Erie oils and for the Union Pacific oils are given in Table 1. The viscosity of the Erie oils is slightly higher than that used on factory test (4) but otherwise the properties are about the same. They correspond approximately to a No. 6 fuel as given by Heath and Albat (11). The viscosity and the Conradson carbon of the Union Pacific oils are very high. The viscosity is 40 per cent higher and the Conradson carbon 100 per cent higher than the values given by Heath and Albat for heavy No. 6 fuel.

The turbine deposit formed after approximately 1200 hours of operation on the Pacific Coast fuel is shown in Figs. 11 and 12. These photographs were taken with the incident light roughly tangent to the surface in or-

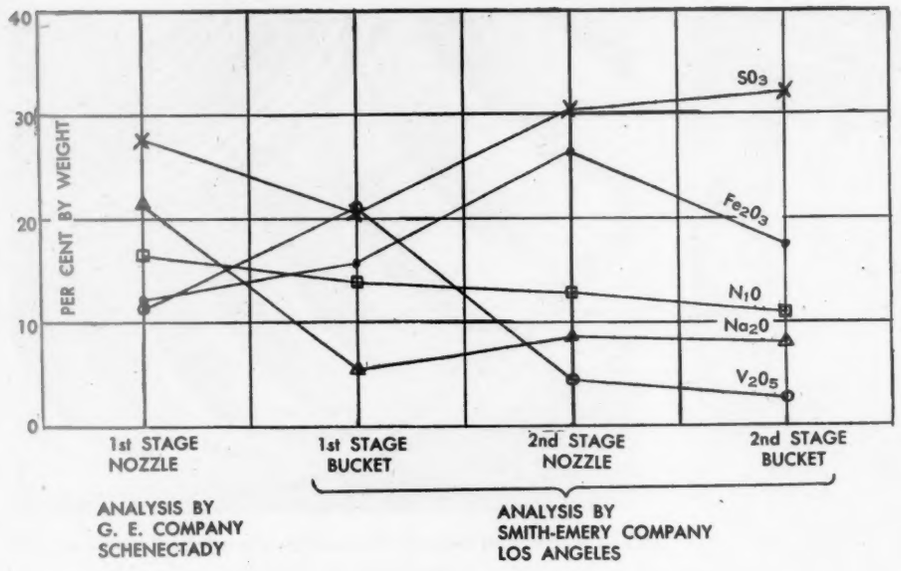

FIG. 13. Main constituents of the oil ash found in a gas turbine after 1200 hr of operation.

der to show the deposit more effectively by means of shadows and high lights. The average thickness in each case was about one thirty-second inch. The deposit was removed by blasting it with hot water from a steam gun; thus it was soluble in hot water but somewhat less so than that which occurred during the factory tests. The complete analysis of the second stage nozzle deposit is shown in Table 2. The main constituents found on this and other parts of the turbine are given in Fig. 13.

The deposit undoubtedly adversely affects the efficiency of the plant but the operating data have not been precise enough thus far to isolate the amount of the effect with any reasonable accuracy. There is also evidence that, at temperatures of approximately 1700 F and above, the deposit greatly accelerates oxidation of metal parts made of 25-20 material. Twenty-five to twenty with 2½ per cent silicon is attacked by the slag much less than the metal without the silicon. There are at least four ways to cope with the ash problem in Bunker C:

1. Use materials resistant to the slag attack.
2. Use hollow and/or otherwise force-cooled nozzle partitions.
3. Use inhibitors in the fuel that will keep the slag or glass formed by the ash in a dry state and that will cover and protect the metal parts.
4. Remove the ash forming constituents from the oil.

Gas turbine builders will no doubt explore the possibility of the first three of these but are probably not in a position to do any significant amount on Item 3. The oil refiners, however, might be able to find ways of removing the ash forming constituents.

The ash problem as it is now can be lived with but surely gas temperatures will be increased to the point where the increased performance is offset by the increased maintenance. Undoubtedly the limiting temperature will be higher without ash than with it, so that the removal of ash from Bunker C if it can be done at a reasonable cost will be worthwhile.

It should be mentioned that in the factory test on the locomotive unit the Bunker C was cleaned by centrifugal means, whereas in the operation of the locomotive it was only screened with fine screen filters. Some evidence can be found in this experience to indicate a small reduction in the ash-forming constituents by centrifuging but the evidence is not now conclusive and in any case the effect is small. Thus the oil suppliers could make a worthwhile contribution by finding inexpensive ways of removing the ash-forming constituents from Bunker fuel.

TABLE 2. Complete analysis of oil ash found on second stage nozzle of a gas-turbine after 1200 hr of operation.

	Percent
Nickel oxide (NiO)	12.9
Iron oxide (Fe_2O_3)	26.5
Sodium oxide (Na_2^0)	8.5
Vanadium oxide (V_2^{05})	4.3
Lead oxide (Pb^0)	0.6
Copper oxide (CuO)	0.1
Total sulfur as SO_3	30.4
Combined water and volatiles	15.0
Water insoluble matter (ignited) (consisting largely of nickel, chromium, iron, and vanadium)	32.6
Acid insoluble matter (ignited)	2.4
Loss on ignition (total volatile matter on sample as received)	30.6
Water soluble sulphuric anhydride (SO_3)	24.8

TABLE 1. Properties of fuel oils burned by a gas turbine locomotive.

Oil designation	Erie residuals 18 samples Range			Up residuals 46 samples Range		
Property	Max.	Min.	Ave.	Max.	Min.	Ave.
Gravity API	14.5	17.6	16.4	3.02	9.0	
Gravity Specific at 100 F	.983	.963	.....	1.038	.993	.998
Pour F	50	34	40	43	9	26.5
Viscosity C.S. at 100 F	459.	193	350.3	2127	711	1336
Viscosity C.S. at 210 F	26.7	17.8	20.84	57.1	14.31	35.11
Carbon residue per cent (Conradson)	10.76	5.65	8.34	20.7	12.0	15.9
B S and W per cent	3.0	Trace	.52	4.0L.A. 1.46	Trace	.37
H_2O by extraction per cent	1.5	Nil	.25	2.7L.A. 1.6	Nil	.43
Sediment by extraction per cent	.81	.012	.13	.094	.0031	.0202
Total ash per cent	.137	.009	.040	.133	.0282	.0471
Water soluble ash per cent	105	41.7	75.51	89.4	10.06	30.47
Water insoluble ash per cent	41.6	31	35.9	87.8	10.85	66.9
Sulfur, per cent of fuel	.98	.602	.776	1.37	1.05	1.17
NA_2SO_4, per cent of ash	85.1	43.8	65.96	92.8	0.40	15.92
V_2O_5, per cent of ash	21.0	1.8	9.47	31.9	1.21	21.21
Stability, N. B. T. L.	.....	.....	.....	.....	.....	.....
Heating valve Btu/lb gross	18,893	18,329	18,577	19,159	17,558	18,176

Samples taken from filling snout, when loco. was fuelled, except L.A. which was from Los Angeles tank.

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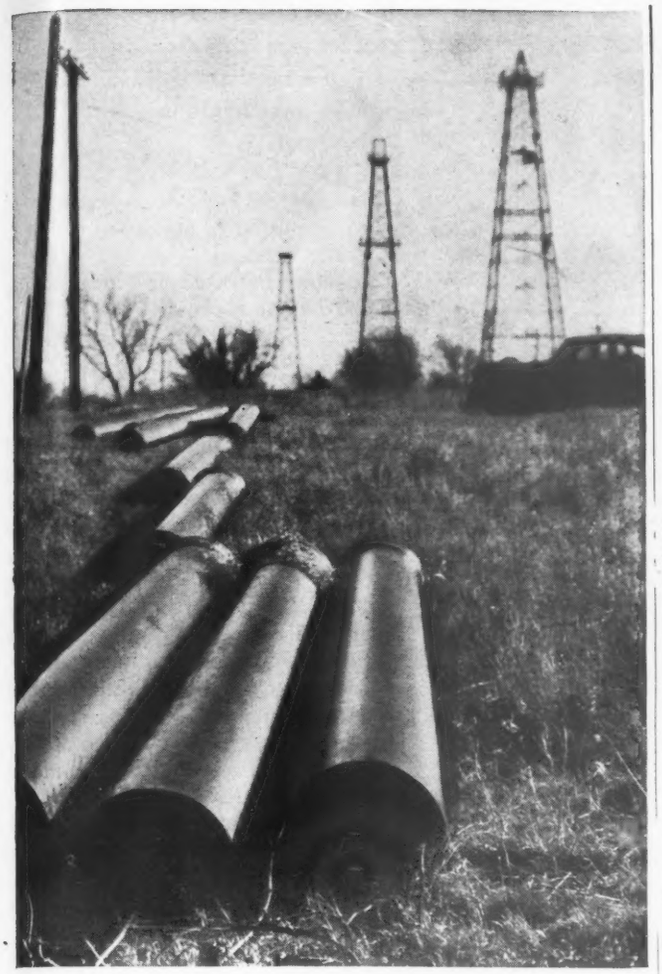

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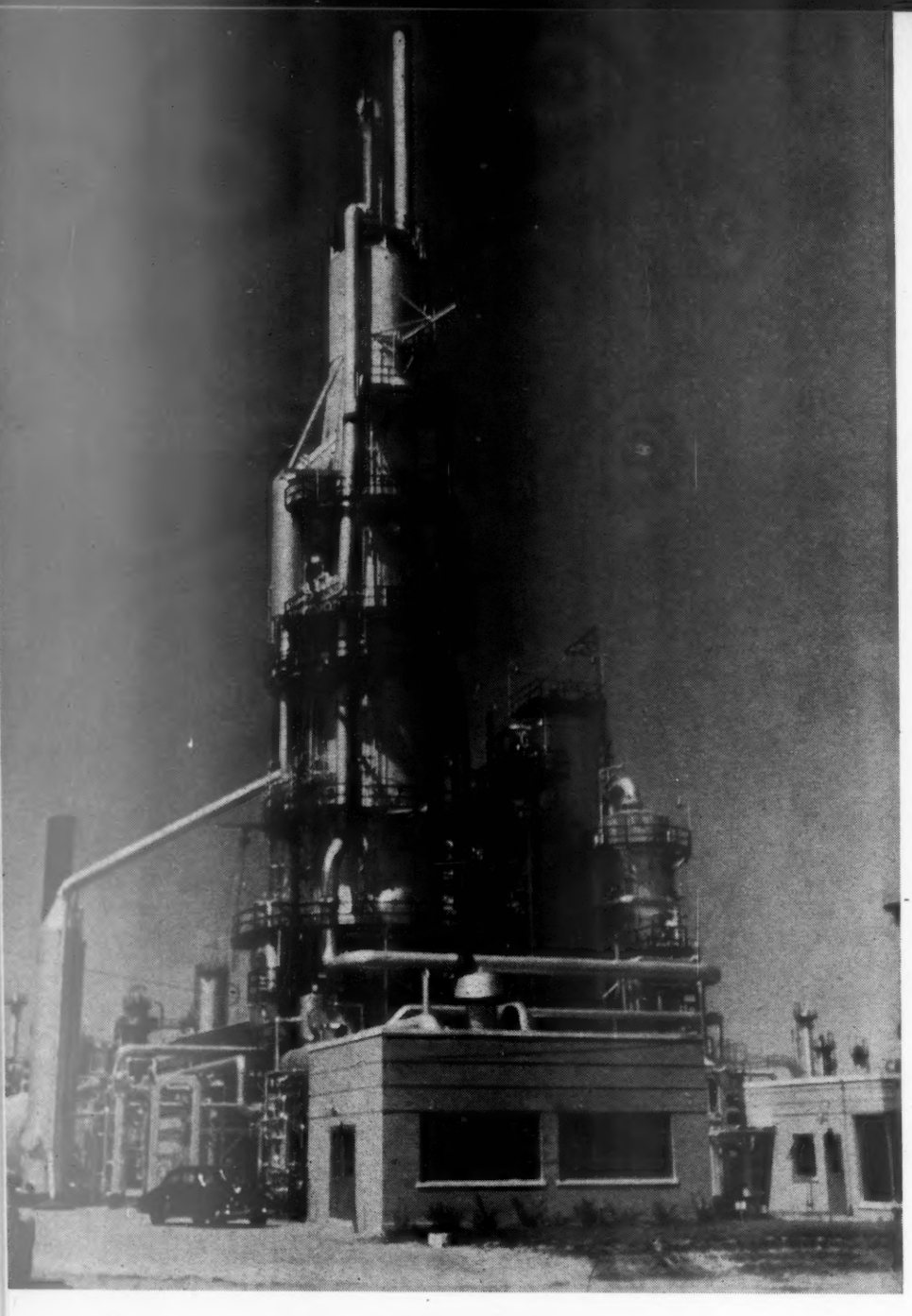

P 721.34

The new Cosden fluid cat cracker with main fractionator and auxiliary column, right, blower house in foreground.

Catalytic Cracker Balances Entire Refinery Operation

Addition of small but adequate fluid unit to other modern facilities brings Cosden refinery up to date

ARCH L. FOSTER

It is an old story now that, of the facts faced by a large number of refiners, small, medium, and large, at the end of the war, the great need was to revamp in part their processing systems to meet the demand for products, old and new. The demand, instead of falling as predicted, increased at surprising and in some measure alarming rates. Alarm was not concerned so much with the increase in available business but in the difficulty of expanding output in almost zero time to meet the demand.

Cosden Petroleum Corporation faced the same prospect as did other refiners. Situated in "the great open spaces," utilizing crudes that have many advantages and a few drawbacks, possessing and operating crude distillation, thermal cracking, and catalytic polymerization facilities, it was seen that these before-the-war-satisfactory units would not meet the requirements. Extensive and intensive study of the entire situation by company and Universal Oil Products engineers disclosed the following needs and decision reached to meet them:

Install a catalytic cracking unit of adequate capacity. Build a gas concentration unit, converting an already installed stabilizer to new uses, and installing a gas absorption system.

Expand the capacity and modernize the catalytic polymerization process to handle the additional quantities of olefins that would be produced by the revamped refinery system.

Last and far from least, build a vacuum distillation unit to aid in preparing feed for these main units.

Design and engineering of this program was handed over to Universal and the fluid unit was built by Refinery Engineering Company according to the data shown later herein.

For a considerable time the refinery has been processing some 17,500 bbl per day of three crudes; Benedum, Howard-Glasscock, and East Howard fields supply the required amounts of crude. The primary analytical data on these crudes are shown in Table 1, which give an approximate idea of the general nature of these crudes. Notable in these data are the values for total sulfur, which range from 1.24 per cent in Howard-Glasscock crude, 1.21 for East Howard, and only 0.05 per cent for the very light Benedum crude, which contains 55 per cent of 400 EP gasoline, 42 per cent total gas oil — available cat cracker charge stock—with no residuum. This crude is "sweet," has no salt content, and does not require desalting in the equipment employed for the other crudes.

The Howard-Glasscock crude ranges normally in salt content from 30 to 50 lb per 1000 bbl, but on occasion may contain as high as 70 lb of salt. Salt content of the East Howard field crude

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may range from 50 to 150 lb per 1000 bbl. Thus both these crudes must be desalted, which is accomplished in six Petreco units operated at about 200 F, and with approximately 5 per cent water added.

Refinery System

Fig. 1 depicts refinery operation for maximum gasoline production. It must be remembered that the data shown here are typical but may vary widely in percentages, etc., the values depending on market demands, proportions of the three different crudes used, and other controlling conditions. It is seen that, for example, more than 11,000 bbl per calendar day is or may be made into total motor fuel production, or nearly 64 per cent of the total crude, a remarkably high yield in any plant.

Under the operating conditions now employed a total of about 21 per cent of the crude charge is converted to No. 6 fuel oil (heavy residual),

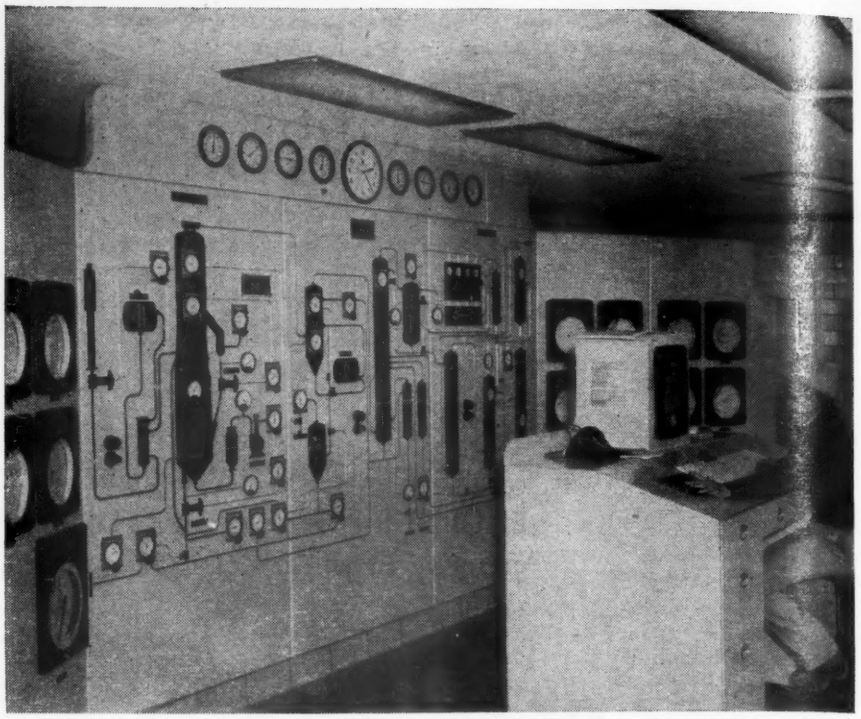


FIG. 2. Panelgraph control board from which fluid is operated.

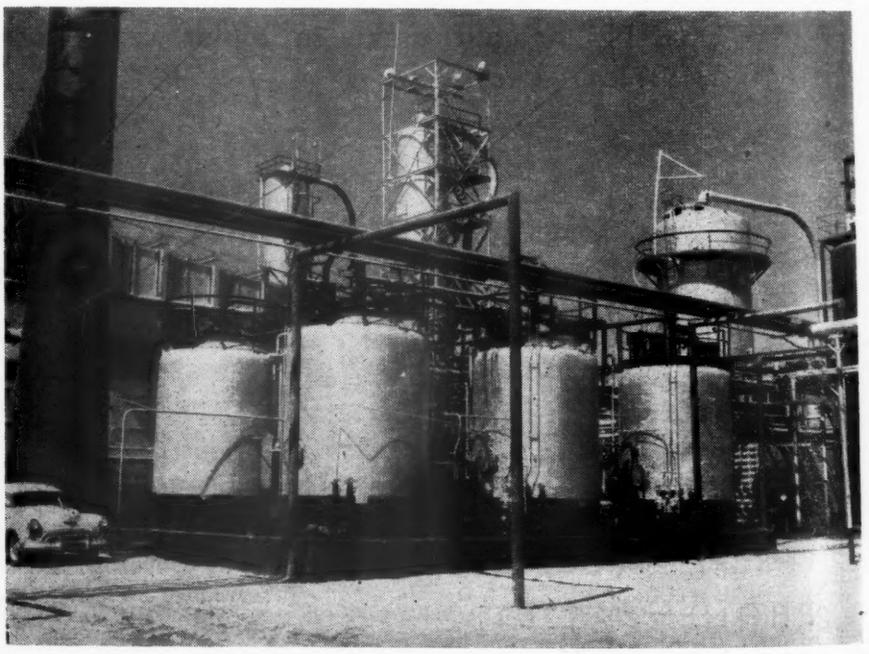
FIG. 3. Fluid unit control room, the "conning tower" of the cracker.

FIG. 4. Six Petreco desalters in foreground, with crude unit heater, and left to right, straightrun gasoline rerun, secondary tower and primary tower.

most of it coming from the Dubbs thermal cracker, or to road and other asphalts, which comprise nearly half of these heavy ends products (9.6 per cent). Asphaltic materials find a ready market in the West Texas area, especially for road building.

The remainder of the crude is converted mainly to diesel fuel (7 per cent), LPG and distillate fuel oil, the latter especially important in winter. Interesting to note is the fact that the straightrun gasoline is treated in a Girbotol unit and is desulfurized catalytically before blending. The combined treated straightrun, thermally cracked and catalytically cracked (heavy) streams receive Unisol and doctor treatment before they are completely refined.

Yield data and laboratory inspections of products are shown in Tables 2 and 3. Notable in these data are the Research octane ratings of the cata-



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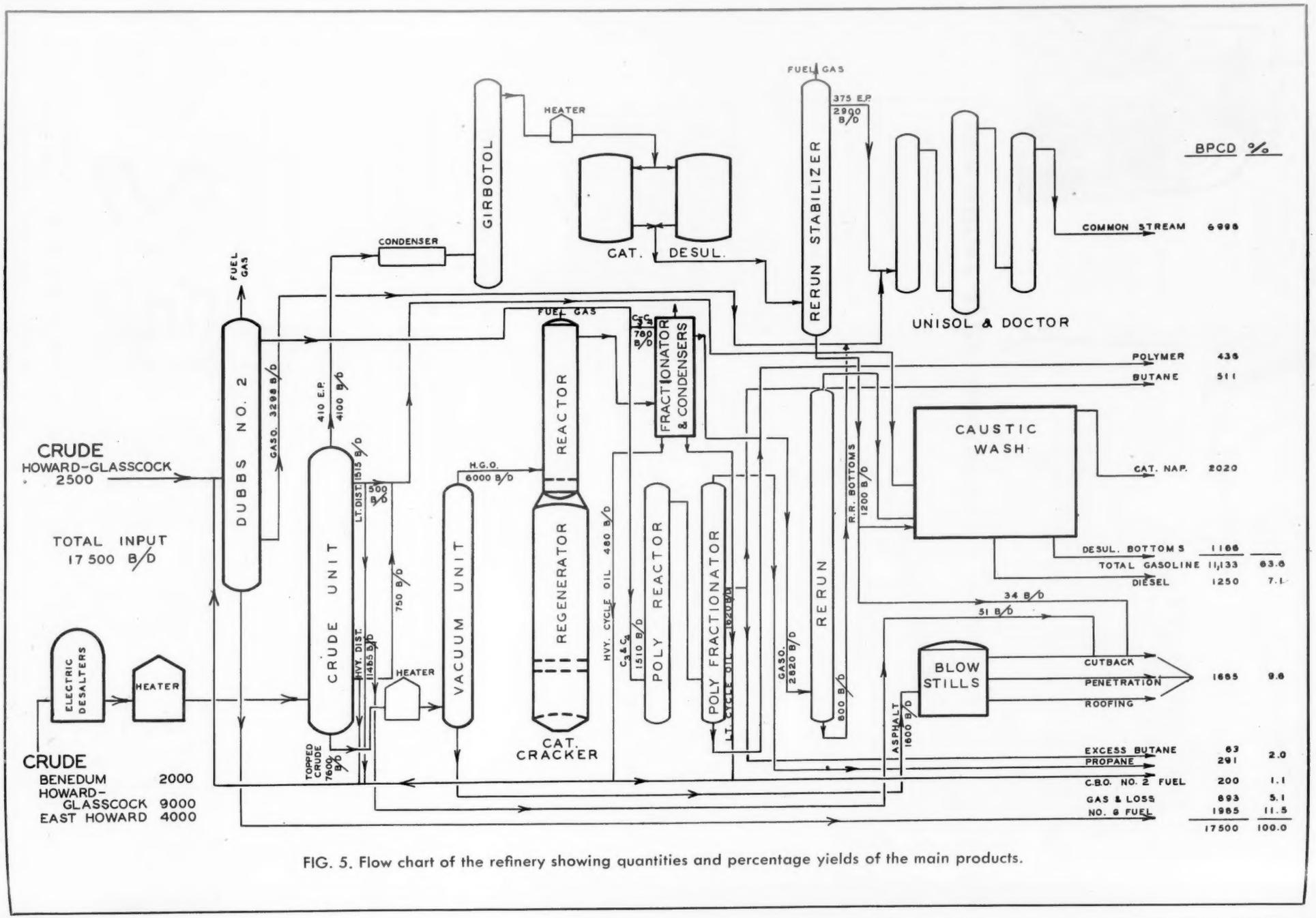

FIG. 5. Flow chart of the refinery showing quantities and percentage yields of the main products.

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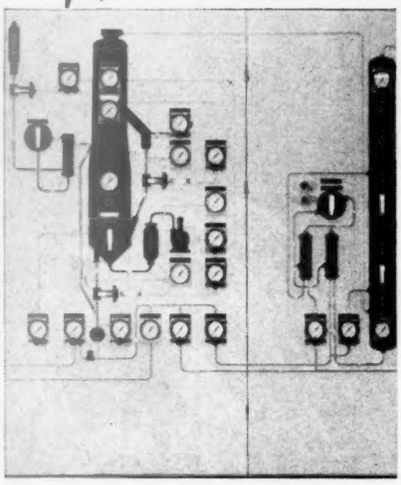

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TABLE 1. Inspection of crudes charged to Cosden refinery.

	Crude Oil	Gasoline 400 E.P.%	Total gas oil	Residuum	Water, gas, and loss
Howard-Glasscock					
Volume % of crude	100.0	22.4	66.4	11.1	0.1
Gravity API @ 60 F	29.4	55.2	28.3	6.4	
Total sulfur %	1.24	0.35	1.03	2.69	
Cold test F below	— 30	....	....	....	
Viscosity Universal @ 100 F Secs.	61.1	....	....	....	
East Howard					
Volume % of crude	100.0	31.4	55.0	12.6	1.0
Gravity API @ 60 F	29.6	53.9	26.9	4.3	
Total sulfur %	1.21	0.11	1.30	3.06	
Cold test F Below	— 30	....	....	....	
Viscosity Universal @ 100 F Secs.	47.6	....	....	....	
Benedum					
Volume % of crude	100.0	55.0	42.0	none	3.0
Gravity API @ 60 F	55.0	64.0	39.4	....	
Total sulfur %	0.05	0.03	....	....	
Cold test F Below	— 30	....	....	....	

TABLE 2. Yields and operating conditions.

Product	BPD	Vol. %
Debutanizer overhead	767	12.6
Debutanized gasoline (5.5 # RVP)	2,781	45.6
Light cycle	1,935	31.7
Heavy cycle & clar. oil (to Dubbs)	527	8.6
Gas (FOE)	198	3.2
Gain	(—)105	(—)1.7
Coke yield, wt. %	....	6.2
	6,103	100.0

TABLE 3. Laboratory inspection data.

	Fresh feed	Gasoline	Light cycle	Heavy cycle	Clarified oil
Gravity, API @ 60 F	26.7	54.0	26.7	22.6	14.0
Distillation,					
IBP	406	98	432	550	....
10	520	130	494	618	....
50	700	246	548	670	....
90	80% @ 760	394	612	732	....
EP	....	434	636	94% @ 760	....
Color	4 Dil.	....	1½	3	....
BS & W	....	....	....	....	0.2
Res. octane, clear	....	89.5	....	....	....
Res. octane, 3cc TEL	....	95.5	....	....	....

lytic gasoline, clear and with 3 cc. TEL, 89.5 and 95.5, respectively.

The Dubbs Unit is a two-coil design, with two heaters on the light and two on the heavy charge streams, charging a total of 2500-3000 bbl per day of Howard-Glasscock crude. The polymerizer unit is a UOP phosphoric acid catalytic, charging normally 1100 bbl of liquid charge and producing between 400 and 450 bbl per day of polymer gasoline which shows 97 Research octane number, clear.

Catalytic Cracker

The catalytic unit is of fluid design, to handle normally 6000 bbl per day of gas oil charge. It is of single-tower design now well known to the industry; the reactor is 13½ ft diameter and 40 ft high and is mounted directly above the regenerator, which is larger, 19 ft 8 in. diameter and 45 ft high. The total height of this combination tower is 151 ft above grade level. For handling the raw product from the cracking operation two towers are provided, the main fractionator being 12½ ft diameter by 62 ft, tangent to tangent, aided by an auxiliary column 10 ft by 38 ft. The regenerator is lined with a 4-in. layer of ganister (gunite) of Insulcrete.

Other equipment includes the five-stage Elliott compressor of centrifugal type, driven by a 1575-hp condensing steam turbine. This compressor supplies air for burning carbon from the spent catalyst. Four I-R (Ingersoll-Rand) compressors handle the gases from the unit, each driven by a 300 hp gas engine, direct-connected. Outstanding in the design and equipping of the unit is the "show-case" control and instrument room, glassed on three sides, the main portion of which is a Panellit graphic control board in which Fisher, Moore, and Foxboro instruments are installed to control, indicate, and record the conditions of operation. (See Fig. 2.) This control room faces the public highway, a point of unusual interest for passersby.

The unit was designed to process

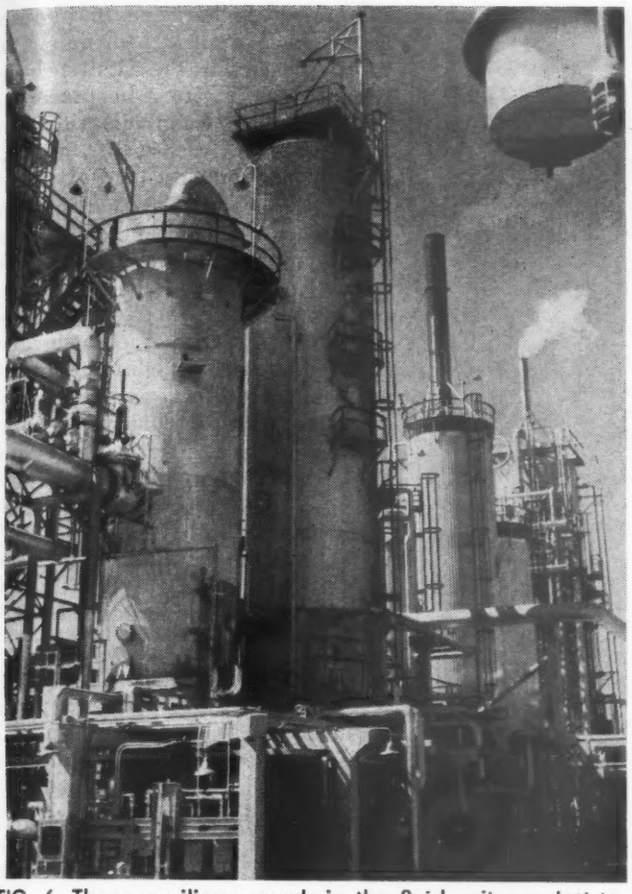
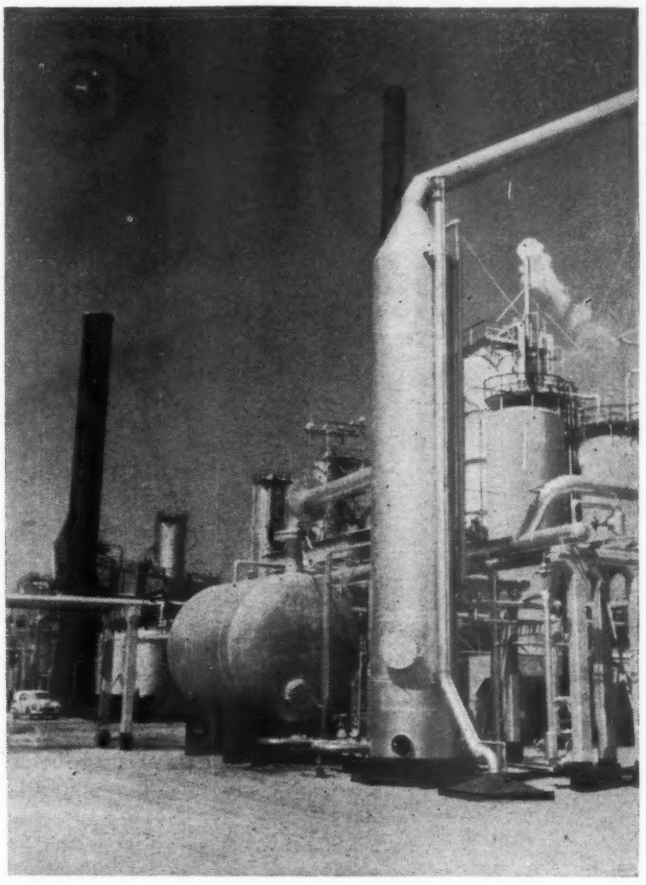


FIG. 6. These auxiliary vessels in the fluid unit are, lett to right, auxiliary column, main fractionator, side-stream stripper that is partly hidden, main cat storage hopper, auxiliary cat storage hopper, and vacuum tower.

FIG. 7. Sump tank and condenser in foreground; inclined pipe is sump stack, tying tank into the main structure.



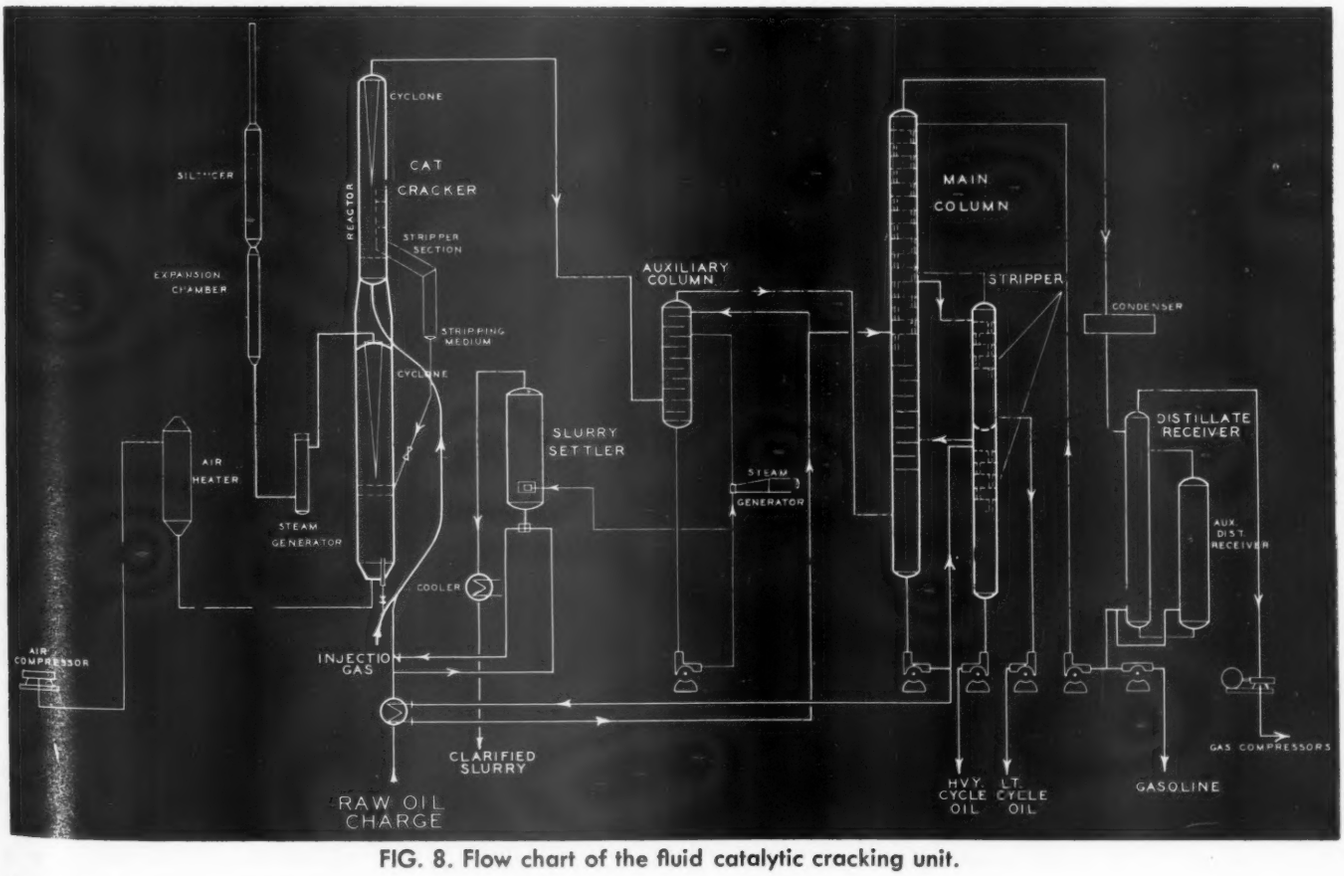


FIG. 8. Flow chart of the fluid catalytic cracking unit.

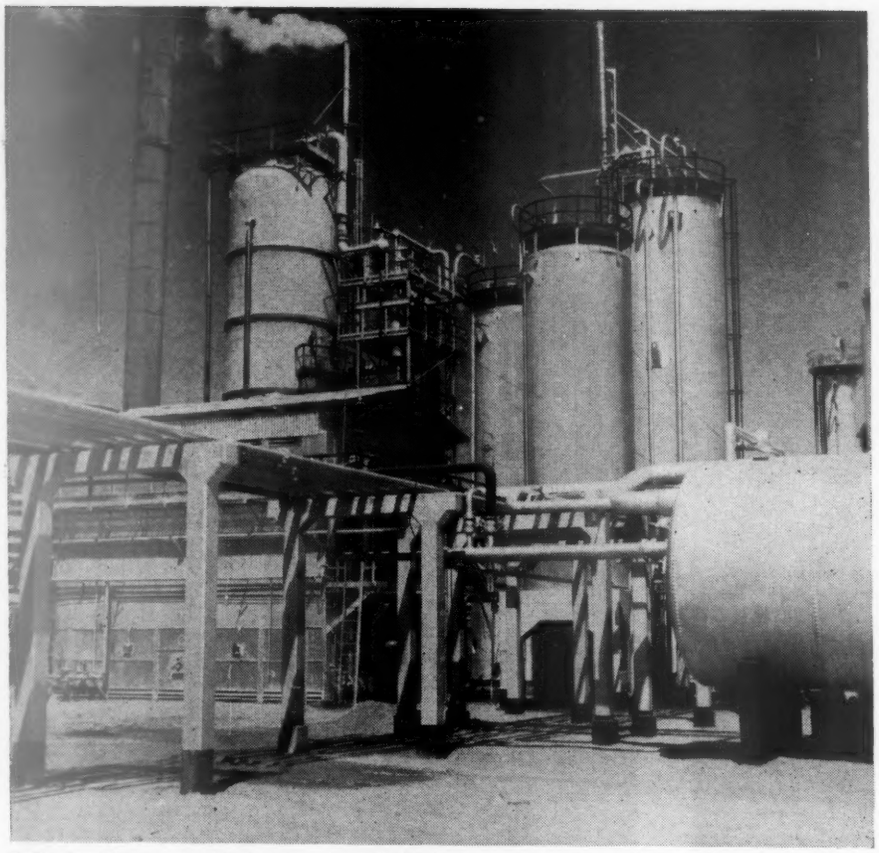


FIG. 9. Vacuum unit heater is at left, then vacuum tower, auxiliary cat storage hopper, slurry settler, and main cat storage hopper.

6000 bbl per stream day of gas oil charge—most of which is prepared in the vacuum unit also provided—to give 50 per cent conversion, mainly catalytically cracked gasoline. Handling this or a smaller charge it has shown 60-65 per cent conversion with products of the qualities shown in Tables 2 and 3. Because of corrosive stocks the vacuum tower supplying most of the charge is lined completely with alloys; furnace tubes are of chrome steel. The vacuum unit supplies about 5400 bbl per day of charge, approximately 28.0 API gravity. The remainder of the cat cracker charge is obtained from the crude direct as virgin gas oil.

After preheating, the charge to the cat cracker is heated to about 900 F by contact with hot regenerated catalyst coming down the standpipe from the regenerator. Catalyst and charge vapors enter the reactor in which a turbulent bed of catalyst is maintained, and during this cycle the charge is cracked to motor fuel, light hydrocarbons — C_3s and C_4s — distillate fuel oil, heavy cycle oils, and noncondensable gases. Overhead vapors from the reactor pass into the fractionator, with gasoline and lighter products overhead. A side stream of light cycle gas oil is withdrawn to the first heat exchanger to preheat raw charge, then is returned to the tower above the light cycle drawoff tray. In addition to this preheat by the light cycle oil the raw charge is preheated also by fractionator tower bottoms, by auxiliary tower bottoms, and finally to 900 F by regenerated catalyst as indicated above.

The cat gasoline is rerun for light and heavy cat naphtha. Light cat naphtha is treated by a regenerative-type caustic wash and inhibited. Heavy cat naphtha joins a common stream of Dubbs thermal gasoline and straight run rerun overhead for Unisol and doctor treating. The light cycle gas oil is caustic-washed when blended with virgin gas oil to make the two "compatible." Heavy cycle gas oil goes to the Dubbs unit, and any, all, or none of the light cycle oil may go with the heavy stream or may be used as distillate fuel oil or for similar uses. Slurry is settled to show about 0.2 lb per gallon of catalyst. Clarified oil goes to Dubbs cracking stock.

Many items of operation are of interest to the refiner who has similar equipment. "Injection gas" to the charge line as normally used is steam; compressor discharge gas may be used if and when wanted, to maintain the proper density in the catalyst-charge riser to the reactor. In practice a highly aromatic fraction is withdrawn from the main fractionator, which is sold for the manufacture of carbon black; the aromatic content must be high, about 40 per cent, to be satisfactory for this purpose, it is understood. Even mercaptans of one, two, three, and four carbon atoms are recovered in a special fractionator, are supplied as warning odorants for natural and other fuel gas lines. These mercaptans are obtained as a Unisol unit by-product, after being released from the alkaline treating solution. Acid oils are also recovered from spent caustic, with yields up to 0.15 per cent of the gasoline. Both Cyanamid MSA and Filtrol SR catalysts have been employed in this unit.

About 2500 lb of steam is used per hour to strip the catalyst in its stripper, to remove the last traces of vaporizable products before the catalyst is transferred to the regenerator. This steam is used at the rate of about 3.5 lb per 1000 lb of spent catalyst. The waste heat boiler produces about 16,000 lb of 150-lb steam per hour from the regenerator flue gases.

Tail gases from the unit are compressed to about 200-215 psig in two stages, and are sent to the primary absorber when fractionator overhead receiver liquid absorbs part of the recoverable hydrocarbons. The remainder of these gases go to the next, or "sponge" absorber and are brought into counter-current contact with light cycle oil as "sponge" or absorption oil. Rich oil from the primary absorber goes to the stabililizer. The sponge oil is returned to the main fractionator to be stripped of the light hydrocarbons recovered.

Overhead liquid from the stabilizer is combined with a similar stream from the thermal cracked distillate debutanizer; the stream goes to the deethanizer which removes both the ethane and up to 90 per cent of the hydrogen sulfide from the propane-butane - propylene - butylene mixture. This bottoms from the deethanizer contains normally about 50 per cent of olefins and is charged to the polymerizer to make 400 bbl per day or more of polymer gasoline. From 150 to 600 grains of H_2S per 100 cu ft of deethanizer bottoms is retained by that stream which is next washed with caustic to remove the last of the sulfide and mercaptans; a water wash then eliminates nitrogen compounds, which are water-soluble, after which the olefins are polymerized. * * *

Electro-Chemical Instrument Records Sulfur Content

Continuous determination and recording of sulfur content of gases and vapors are very important operations accomplished by a new instrument.

RICHARD SNEDDON†

THE petroleum industry has long sought a means of determining with greater speed and greater accuracy the concentration of various types of sulfur compound in field and refinery gases. These sulfur compounds are of major importance in many respects: They are, of course, a factor in the purchase and sale of fuel gas, because of their corrosive effects on lines, machines, and appliances. They are employed for the odorization of gas in distributing systems to aid in the quick disclosure of leaks. They are often an essential consideration in blending and treating operations, and there are other departures and departments in which knowledge of the sulfur content of one or more gas streams is a prime necessity.

Of especial interest, thus, to chemists and petroleum technicians generally, is the development of an instrument, known as the Titrilog,* that titrates for organic sulfur compounds in any gas stream or atmospheric system automatically and continuously. This recording titrator is the by-product of wartime research, originally contrived to establish a reliable method for the detection and recording of minute traces of mustard gas in air. The instrument is adjustable to a wide range of concentrations and conditions, and can be set to give optimum accuracy and range for any given application. Its keen sensitivity to hitherto indeterminable concentrations makes it ideal for the study of air pollution, and for many petroleum problems in which trace quantities of organic sulfur are involved. It has measured mercaptan sulfur content of gases as low as 0.005 gr per 100 cu feet. Some idea of the scale of adjustment may be gleaned from the fact that for the determination of sulfur in a raw gas, the setting would be for the maximum concentration, say 20 gr per 100 ft; in a scrubbed gas, the setting would be for about 2 gr per 100 ft.

The instrument utilizes Bromine as the titrating agent. The oxidation of organic sulfides by bromine may be taken as an example. The equation for the reaction is as follows:

$$RSR + Br_2 + H_2O = R_2SO \times 2H^+ + 2Br^-$$

In early experiments considerable difficulty was experienced in obtaining accurate results because of the poor stability of the dilute reagent solutions employed. Potentiometric end point determinations, however, proved helpful, and further success was achieved when electrolytic generation of the bromine reagent was employed. In spite of the improved accuracy, titration still had to be on a batch basis, and that, in the mind of the modern chemist, is an intolerable situation. In 1948, it was suggested by one experimenter that potentiometric end point determination and electrolytic reagent generation could be coupled to produce a fully automatic, continuously titrating instrument. This is done by utilizing a feed-back amplifier to control the rate of bromine generation so that it will always equal the rate of absorption of reactive gas in the titration cell.

The Titrilog principal of operation will be better understood by reference to the schematic drawing of the amplifier and titration cells, Fig. 6. The titration reaction takes place in the inner chamber A, where gas is absorbed. Bromine is generated from electrode 1. Electrode 2 in the same compartment is of platinum and is responsive to changes in bromine concentration. The outer cell B acts as a reservoir for electrolyte and contains electrodes 3 and 4, which complete the electrical circuits. Electrode 3 completes the electrolysis reaction, generating hydrogen which is vented and takes no part in the titration reaction. Electrode 4 is a calomel half cell type of reference electrode against which the voltage of

*Consolidated Engineering Corporation.
†Pacific Coast Editor.

EXCLUSIVE

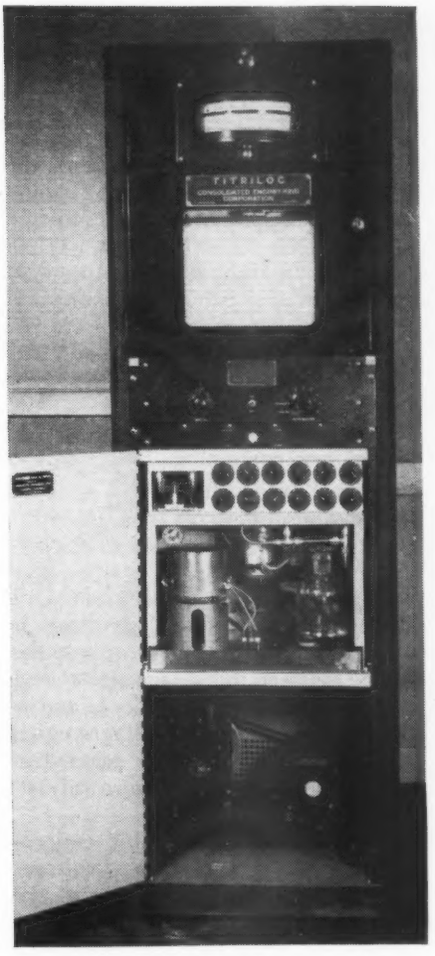


FIG. 1. Titrilog instrument.

FIG. 2. Instrument closed.

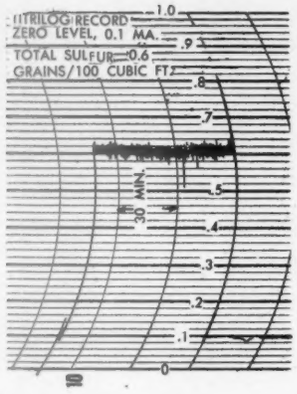


FIG. 3. Analysis of natural gas containing 0.6 gr per 100 cu ft total sulfur.

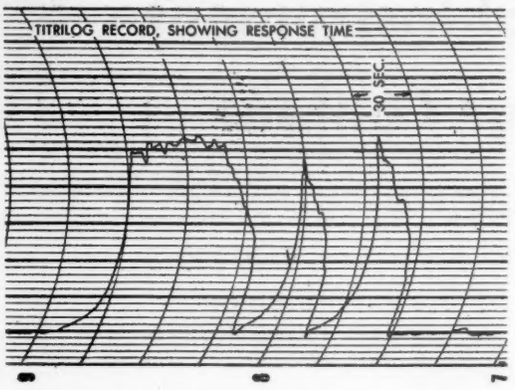


FIG. 4. Comparison of a continuous titration of one-minute duration.

the bromine-sensitive electrode 1 is developed. The reference voltage is connected in the circuit to oppose the voltage between the sensor electrode 1 and the reference electrode 4, and is adjusted to make these voltages equal at some desired bromine concentration. This is called the zero adjustment.

Variation of the bromine concentration gives rise to a net voltage, which is applied to the input of the negative-feed back amplifier. The output current of the amplifier is applied to the generation of bromine. The chemical cell thus forms the input section of the amplifier feed back loop. In practice then the zero adjustment is set for very low bromine concentration. No bromine is present in the cell when operation begins. This gives rise to a high net input voltage to the amplifier. The amplifier, therefore, develops a high momentary bromine generating current which falls rapidly as the concentration of bromine in the cell approaches the set value. The current does not fall to zero, because the gas passing through the cell continuously carries out a very small quantity of bromine. The amplifier simply operates to equalize the rate of generation to the rate of loss, making the residual input voltage to the amplifier infinitesimal as compared to the amplifier output when no titration is taking place. This low steady current is called the zero-level current.

The titration reaction takes place on the addition of reactive gas to the gas stream. The bromine concentration in the inner titration cell falls as reaction takes place. The sensor electrode voltage changes, giving rise to a net voltage input to the amplifier, which responds by increasing the feed-back current, hence the rate of bromine generation, until equality is established between generation rate and gas absorption rate. The amplifier input voltage is thus held at a very small value. The amplifier gain is made high so that bromine concentration changes required to drive it to maximum output are low enough in terms of bromine generating current to be neglected in efficiency calculations. The net bromine generating current being a measure of the quantity of gas titrated, the latter may then be calculated from the Faraday equivalent of the current, as follows:

$$\frac{\text{amp sec}}{96500} \times \text{equivalent wt} = \text{wt of gas}$$

Or, if gas volume is desired,

$$\frac{\text{amp sec}}{96500} \times \text{equivalent volume} = \text{volume}$$

In transforming the basic titration idea into an instrument capable of automatic and continuous operation, the greater part of the development time was required to achieve continuity. The problems of maintaining the cell electrolyte in constant composition and at the same time protecting against build-up of reaction products, were solved by slowly circulating electro-

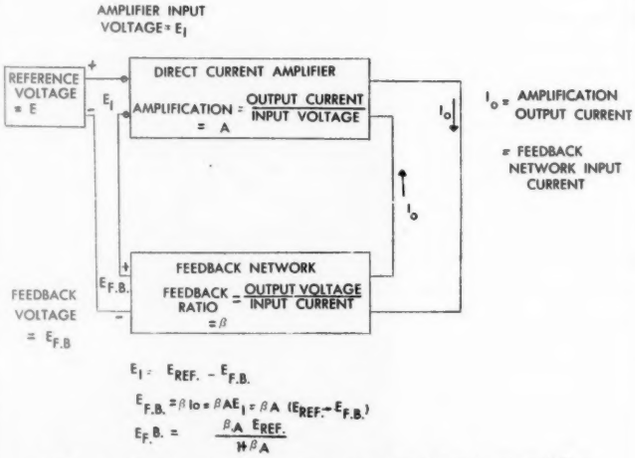

AMPLIFIER INPUT VOLTAGE = E_I
REFERENCE VOLTAGE = E
DIRECT CURRENT AMPLIFIER
AMPLIFICATION = OUTPUT CURRENT / INPUT VOLTAGE = A
I_o = AMPLIFICATION OUTPUT CURRENT
= FEEDBACK NETWORK INPUT CURRENT
FEEDBACK NETWORK
FEEDBACK RATIO = OUTPUT VOLTAGE / INPUT CURRENT = β
FEEDBACK VOLTAGE = $E_{F.B.}$
$E_I = E_{REF.} - E_{F.B.}$
$E_{F.B.} = \beta I_o = \beta A E_I = \beta A (E_{REF.} - E_{F.B.})$
$E_{F.B.} = \frac{\beta A E_{REF.}}{1+\beta A}$

FIG. 5. Block diagram-inverse feedback amplifier.

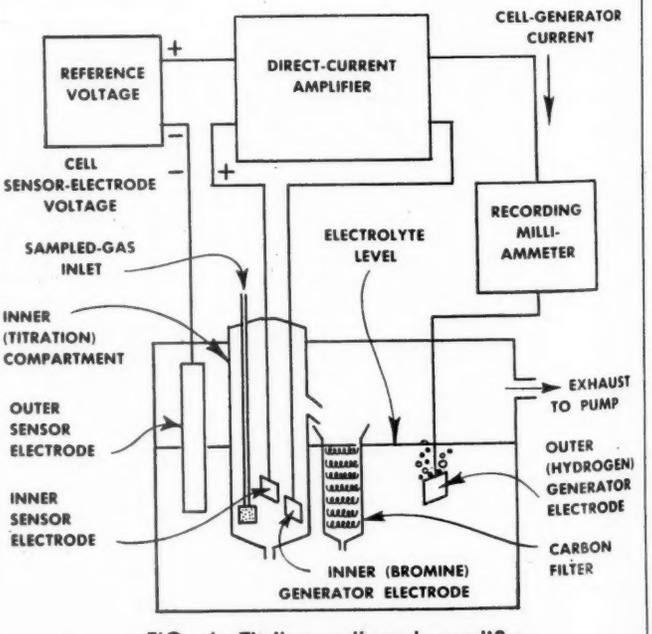


FIG. 6. Titrilog cell and amplifier.

lyte from the inner cell and through the outer cell by means of the gas flow. Zero level generation is affected by changes of temperature in the sample cell. This difficulty was overcome by immersing a specially designed compensating temperature-sensitive element in the electrolyte. Other necessities were the rectification of amplifier voltage output, elimination of oscillation in the amplifier circuit, regulation of the gas feed, and provision for the measurement of the individual gases in a mixture.

An illustration of the complete Titrilog is shown in Fig. 1. The control panel is situated below the recorder and is mounted on the amplifier chassis. The filter and cell rack are mounted immediately below the amplifier, and a standard vacuum pipe, designed for continuous operation, is fixed to the floor of the cabinet. Connections are of multiple-connection cable so that the amplifier may be partially withdrawn for examination or service while still in operation, or may be exchanged quickly and simply. The whole is assembled in a compact unit that can be installed with very little floor space, and it is provided against every foreseeable untoward contingency. It contains a series of filters and a gas pressure regulator, and is fitted with humidity controllers to guard against transfer of water either to or from the cell electrolyte during operation.

The instrument has been thoroughly tested for sensitivity and accuracy, and control factors and their effects have been established. Particular attention has been given to the analyses of fuel and process gases for the sulfur compounds that they ordinarily contain, and it has been found that when the Titrilog has been calibrated for pure gases of known content, that results have been reproducible to the accuracy of the recording meter, which is approximately $\pm$ 1 per cent. It is believed, however, that the overall data so far accumulated are reliable to approximately $\pm$ 5 per cent at titration levels above mid-scale.

The measurement of the sulphur concentration is accomplished by titration with bromine, generated as explained in the solution that absorbs the sulphur compounds from the gas stream. The recording chart readings are therefore actually milliamperes of bromine generating current. The illustration, Fig. 3, is the record of the analysis of a natural gas containing 0.6 gr per 100 cu ft total sulfur. Two levels are shown—the lower one at 0.1 milliamperes is the set "zero" level of bromine generation when no sulfur is present in the gas. This is subtracted from the total current to obtain the net titration, hence a direct measure of sulfur concentration. Chart readings may be made directly in terms of sulfur concentration when the bromine required per mol for titrating of various compounds is known.

In contrast to cyclic systems that operate alternately on absorption and titration, the Titrilog is truly continuous. It furnishes a record of instantaneous variations in sulfur concentration. Fig. 4 shows a comparison of a continuous titration (of one minute duration) with one in which the gas supply to the instrument is on for 20 sec and off for 20 sec. Note that the maximum titration level for an increase in concentration is reached in 20 sec.

Has Various Uses

Needless to say, calibration studies are continuing with a wide variety of compounds, but the instrument has already well demonstrated its application for many purposes, and new uses are being suggested daily. The ability of the instrument to record certain other compounds as well as total sulfur in a stream adds greatly to its versatility. Three fluid absorbers permit absorption of individual compounds before the sample enters the reactive cell. Thus by routing the sample directly to the cell or first conducting it through one or more of the filters, certain separations can be contrived.

As an example, controls may be set to direct the sample first to the reactive cell, then through an H_2S absorber, and finally through an H_2S and mercaptan absorber. The first recorded level in such an instance would represent total sulfur, the next would give total sulfur less H_2S, and the last would be total sulfur less H_2S and mercaptans. By simple arithmetic, thus, the quantities of H_2S, mercaptan. and residual sulfur could be separately derived. Each step in the cycle, incidentally, requires 15 minutes and it is repeated automatically. It is also of interest that the instrument may be modified to record total sulfur in four different streams alternately in a repetitive cycle.

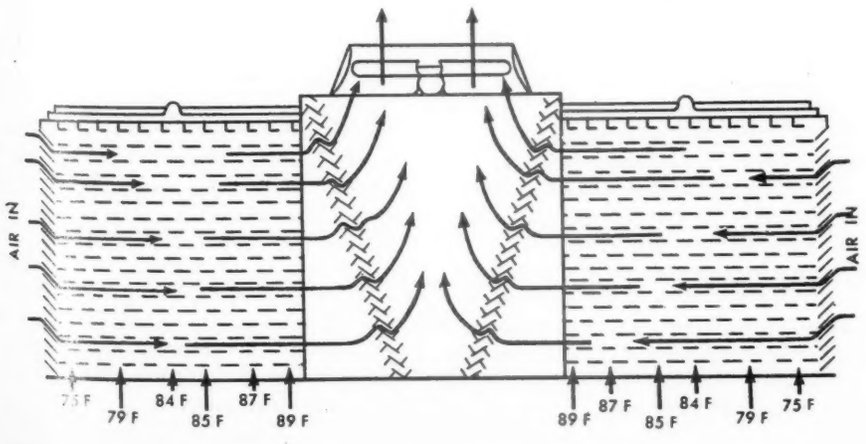
As might be expected, the Titrilog lends itself very effectively to the almost immediate detection of composition changes, a faculty that is itself very valuable to field and refinery operators and to pollution engineers. However, as indicated, determinations of total sulfur and individual compounds in gases and atmospheric systems are also carried on continuously and satisfactorily with known mixtures, and there is no doubt that as further calibration data are obtained, the applications of this interesting development in instrumentation will be greatly extended. * * *

PLANT AID

Water at Two Temperatures From the Same Tower

There is temperature stratification in the cold-water basin of a cross-flow cooling tower. Many users are capitalizing on this feature for special process cooling by collecting water near the wet-bulb temperature of the air. This is accomplished by building a partition in the cold-water collecting basin near the louvered side walls of the cooling tower. Diagram shows typical water temperatures in a cross-flow tower just before water enters the cold water basin. Temperature of water in cold water basin averages 85 F.

H. E. Degler, The Marley Company



NEWS

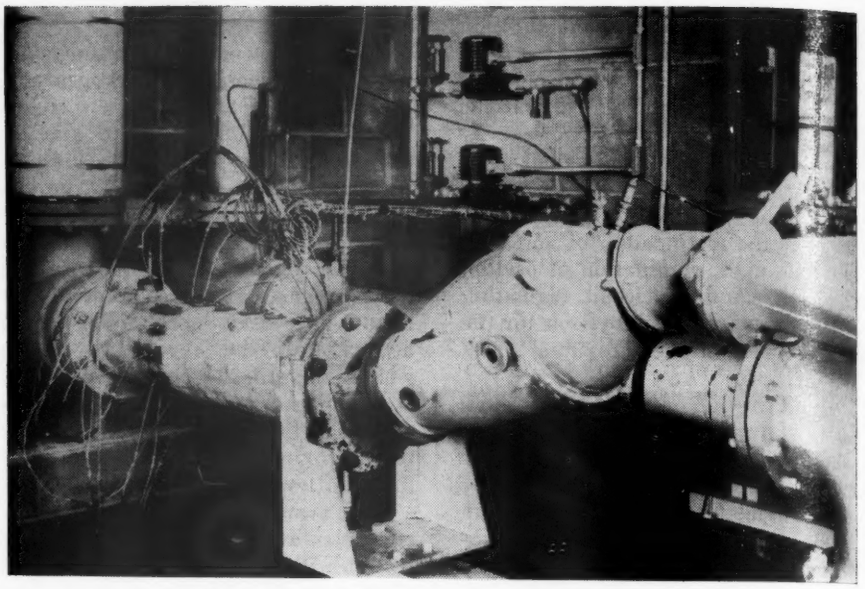
Texaco Opens Jet Lab

The new Texaco jet engine test laboratory at the company's Beacon, New York laboratory has been placed in operation. A Pratt and Whitney jet combustor unit is installed in the test cell, with 18 thermocouples installed to indicate outlet temperatures that may reach 1600 F. Engines built around such combustors are reported to "rev up" more than 5000 lb thrust; typically they are installed in Navy Grumm and Panther jet planes.

To Build Catalyst Plant

American Cyanamid Company announced plans for construction of a $3,000,000 plant in East Chicago, Illinois. The new plant will produce cracking catalysts for the important segments of the petroleum industry in the Midwest and along the Atlantic seaboard. Present capacity will be increased by more than 50 per cent, which will mean production of more than 3000 tons of these catalysts per month.

It is expected that the new facilities will be in operation towards the middle of 1951.



Combustor in Texaco jet engine test cell.

Gulf to Install World's Largest Cat Cracking Unit

Gulf Oil Company has completed contract negotiations for building a 60,000-bbl per day fluid catalytic cracking unit. The plant will be erected at the company's refinery at Port Arthur, Texas and the proposed output will be about 20 per cent greater than any similar operation, the company stated.

The new cat cracker will produce ingredients for aviation gasoline, materials for synthetic rubber production, high quality automotive gasolines, and fuel oils. Scheduled for completion during the late summer or early fall of 1951, the new unit with auxiliary equipment necessary for its operation, will cost about $8,000,000. This will make Gulf's eighth cat cracker.

Sinclair Opens LPG Unit

Sinclair Refining Company has completed and placed on stream at its Marcus Hook Refinery, a new unit for the production of liquefied propane gas. Construction of this unit was necessitated by the increased demand for LP-Gas in the North Atlantic seaboard area, the company stated.

The new unit has a capacity of 1100 bbl daily of liquefied propane gas, and is currently producing a dry, low olefinic content LP-Gas products, which meets all NGAA specifications for commercial propane. Shipments of the gas are being made daily by tank-car and truck to consuming centers in New York, New Jersey, Pennsylvania, and the New England states, and Canada. Heretofore shipments were made from the Mid-Continent areas.

Ark-La Gas Gets Compressor Station

A new compressor station is to be built for Arkansas-Louisiana Gas Company at Blanchard, Louisiana, to be completed by late 1950. This new station will install 4200 compressor horsepower, to handle 65,400 Mcf of gas daily. The Arkansas-Louisiana Gas Company will design and engineer this station, which will be built by Contractor Delta Engineering Corp.

Cancels Garden City Plant

Stanolind Oil and Gas Company has cancelled plans for the building of a synthetic gasoline plant in Garden City, Kansas. The company announced on March 6, 1948 that it planned to build a synthetic gasoline plant to employ 425 men. Cost was estimated by outside sources at up to $80,000,000. The company said it was postponing construction due to rising construction costs.

Stanolind officials announced, however, that it intended doubling the capacity of its Stano plant near Ulysses, Kansas. At the present time it processes 100,000,000 cu ft of Hugoton field gas daily, recovering LPG and natural gasoline.

Order Propane Buses

What is believed to be the largest single order for propane powered units was placed recently when the Chicago Transit Authority placed an order for 500 propane powered buses. CTA officials stated that propane buses were chosen over conventional models because of more economical operation, and propane would less likely be rationed than gasoline.

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NEWS

Socony Builds TCC Unit At East Chicago Refinery

A new thermofor catalytic cracking unit is to be built for Socony-Vacuum Oil Company at its East Chicago, Indiana, refinery by C. F. Braun Company, contractors. The new unit will have 15,000 bbl per day throughput capacity, increasing by 50 per cent the capacity of the Houdry unit, which the new one will replace. This makes 8 TCC units under construction or to be completed for Socony during 1950.

Other units are at Buffalo, Beaumont, Brooklyn, Trenton (Michigan), and Augusta (Kansas), in all of which Houdry units are being replaced. Meantime, Standard Oil Company (Ohio) has licensed from Socony two more units of the simplified TCC design, to be built at Sohio's Cleveland, Ohio, refinery.

Plans Packaged TCC Unit

New Mexico Asphalt and Refining Company has contracted with Southwestern Engineering Company of Los Angeles, California for a 6000-bbl per day thermofor catalytic cracking unit at its Artesia, New Mexico refinery. Present operations of the New Mexico Asphalt and Refining Company's Artesia operation include crude topping, desulfurization, and thermal cracking, charging New Mexico and West Texas crudes.

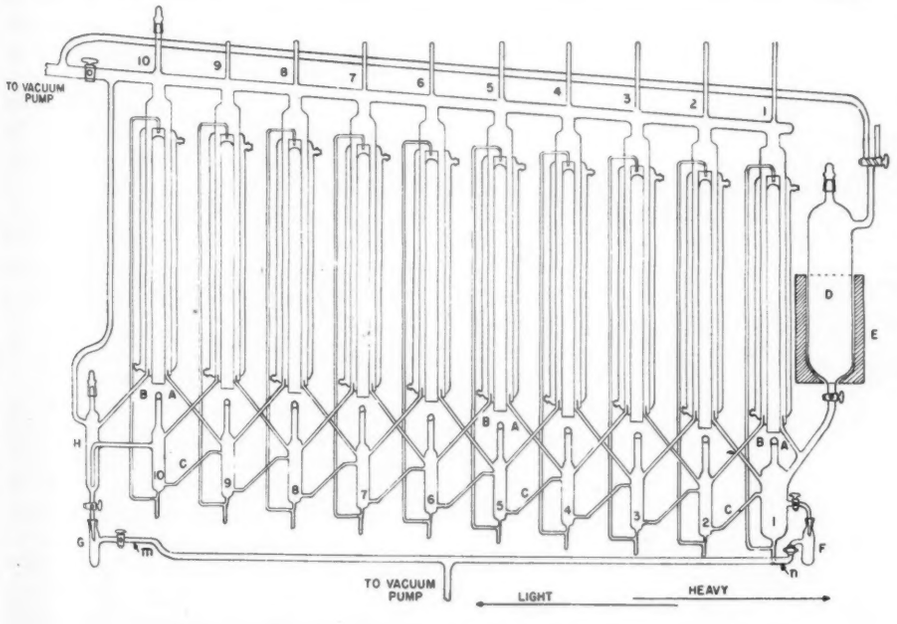
The proposed refinery operation will split the crude charge to the topping and TCC feed preparation section. The topped crude from the topping section will also charge to the TCC feed preparation section. Straight run gasoline will charge to the desulferization unit. Overhead from the TCC feed preparation section will charge to the TCC Catalytic section. Bottoms from the TCC feed preparation section and the TCC cycle oils will charge to the thermal cracking unit. Gas from the thermal cracking unit and TCC gas recovery section will charge to Model 3-C Poly Plant.

Products of the proposed operations are 92.6 F-1 octane premium gasoline, 86.0 F-1 octane housebrand gasoline, 49.8 cetane diesel oil, 250 SFS at 122 F heavy fuel oil and fuel gas. It is expected that this plant will be completed in 7 to 10 months.

Sunray Rebuilds Refinery

Sunray Oil Corporation will rebuild and modernize its Santa Maria, California, refinery, portions of which were destroyed by fire in late June. Engineering studies are being made to determine the extent of improvements required to make the plant one of the most modern petroleum asphalt plants on the West Coast. The natural gasoline plant section of the refinery was not appreciably damaged by the fire, but the topping plant along with tanks, pumps, and miscellaneous equipment will be rebuilt. The refinery vis-breaker unit was partially destroyed and it will be replaced along with necessary auxiliary equipment.

The plant has a refining capacity of 7500 bbl of crude oil daily, and the rebuilding program should be completed in approximately 90 days.



National Bureau of Standards multi-column molecular still.

Continental Completes Three Gas Plants in Texas

Continental Oil Company has recently completed three gas plants in Texas at a total cost of nearly $5,000,000. Completed plants include the expanded Rincon natural gasoline plant, near McAllen; a natural gasoline plant in the Todd (Deep) field, Crockett County, West Texas, and a gas compressor plant in the Slick-Wilcox field, near Kenedy.

Continental, in partnership with Rice Institute and others, has completed an extensive enlargement program at the Rincon Natural Gasoline Plant. Daily capacity of the unit has been increased from 13,000,000 to 20,000,000 cu ft of gas and daily production capacity is approximately 6000 gal of liquid petroleum gas and approximately 25,000 gal of gasoline.

First of the Continental-operated plants completed this year was the natural gasoline plant in Todd (Deep) field. The Todd unit has a daily capacity of 60,000 gal and is handling all of the gas produced in the field, which was discovered in 1940.

The Slick-Wilcox compressor plant has a rated capacity of 10,800,000 cu ft of gas daily. Gas from the plant is utilized for gas-lift operations in the field and is sold to United Gas Company. Continental owns 49 per cent interest in the plant.

Madorsky of NBS Designs Molecular Still

A multi-column, countercurrent molecular still as designed by Dr. S. L. Madorsky of the National Bureau of Standards, has been announced, and is discussed at length in the *Journal of Research of the Bureau*, vol 44, page 135 (1950). It may be obtained on request to the Technical Reports Section of the National Bureau of Standards, Washington 25, D. C.

The still consists of 10 columns of Pyrex glass. They may be made of any other substance such as metal and any number of columns may be included if desired. These columns are arranged at successively higher levels, connected so that residues or heavy fractions from the bottom of each column flow by gravity to the next column below, while light fractions are pumped from column to column, upwardly.

Each column in the new still corresponds to a single cell in earlier stills and avoids mixing of vapors between stages and improving efficiency. A magnetic pump and reservoir is provided at the bottom of each column. The unit is claimed to effect great savings in time, materials and labor, making the fractionation process a continuous one.

Sun Oil Uses Radioactivity in Catalytic Cracking

A new application of atomic energy and radioactivity is being made by Sun Oil Company, according to C. H. Thayer, vice president of manufacturing. With radium and Geiger counters Sun Company scientists are able to follow the flow of cracking catalyst through the cracking process. Because of the abrasive action of catalyst circulating at the rate of 200 tons per hour, measuring devices were impracticable. By placing radium in known quantities, and Geiger counters at opposite sides of a catalyst transfer vessel, Sun technologists were able to determine the amount of catalyst passing those points, by measuring the amount of radium gamma rays that pass through the catalyst stream in unit time. The rate of gamma ray penetration is proportional to the amount of material through which these rays must pass. Knowing the resistance of the steel, insulation, etc., forming the vessel, the amount of catalyst passing a given point in unit time can be determined by the Geiger counter indications. These indications are recorded in the plant unit's control room. Ten instruments are employed, 4 of which record catalyst level over a distance of 35 ft, 2 over 18 ft, and 4 over 8 ft. These instruments were made by Instruments, Inc., of Tulsa, Oklahoma.

PLANT AID

How to Calculate Accurately Boiler Efficiency

This chart indicates the efficiency of a boiler with surprising accuracy, provided the temperature of the chimney and the heat value of the coal or oil fuel are known.

Example: If coal of 12,000 Btu per pound is being burned, and if the chimney gas temperature is 600 deg F, run a straight line through the 12,000 (Column A) and the 600 (Column B) and the intersection with Column C gives the boiler efficiency as about 68.8 per cent. The broken line drawn across the chart (long dashes) shows how easily it is done.

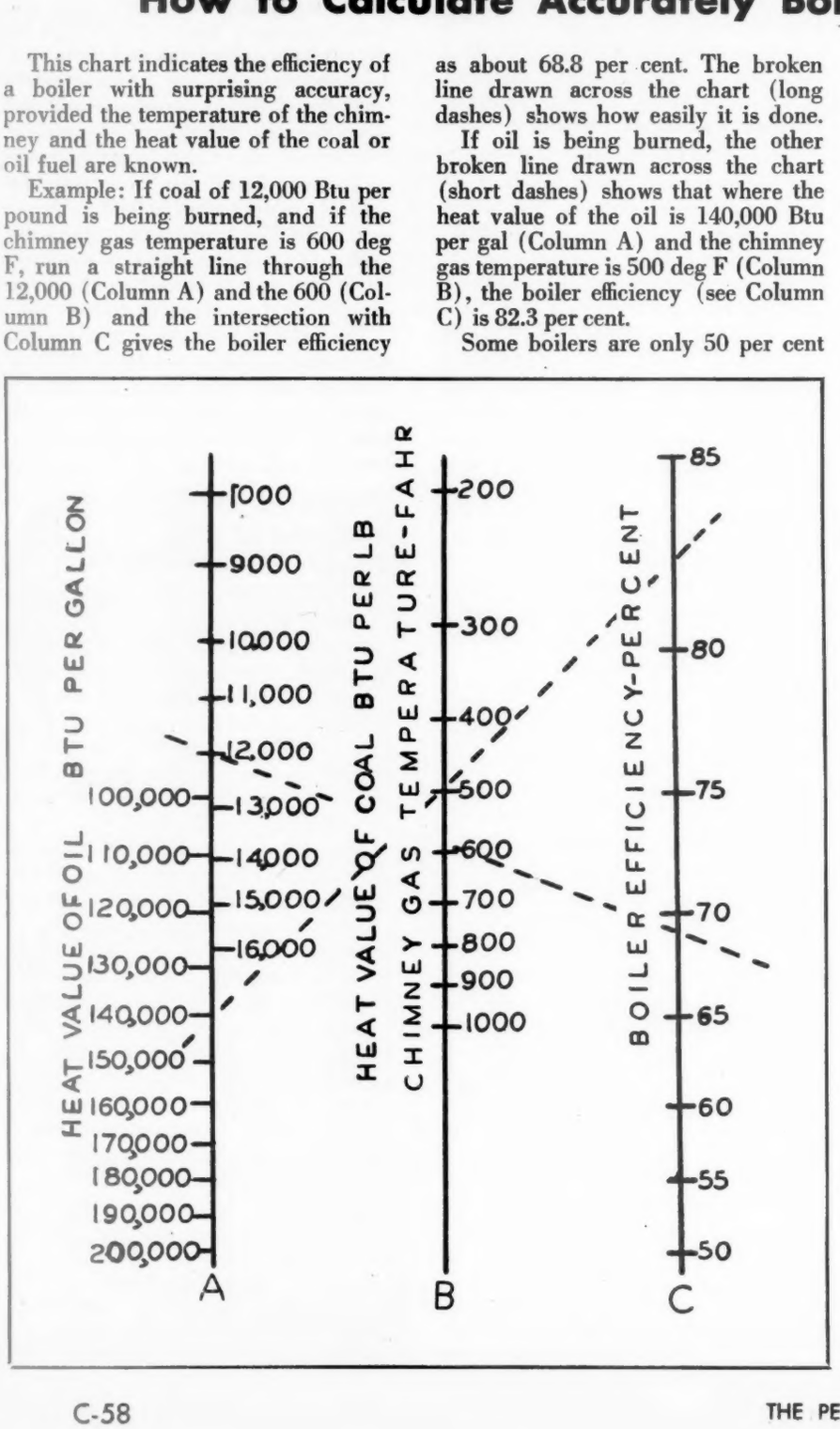
If oil is being burned, the other broken line drawn across the chart (short dashes) shows that where the heat value of the oil is 140,000 Btu per gal (Column A) and the chimney gas temperature is 500 deg F (Column B), the boiler efficiency (see Column C) is 82.3 per cent.

Some boilers are only 50 per cent efficient. This means that 1000 tons of coal are wasted out of every 2000 tons burned. In a plant burning 2000 tons of coal per year, let us assume that modernizing the boilers will increase the efficiency from 50 to 60 per cent. The coal burned during the year will then amount to only 1666⅔ tons (1000 ÷ .60) instead of 2000 tons. This is a saving of 333 1/3 tons of coal per year. At $4 per ton, this amounts to a saving of $1333 per year, very likely enough to pay the cost of the modernizing in the first year. Under these circumstances, not only would the efficiencies of the boiler be increased but the horsepower would also be increased. At 50 per cent efficiency, such a boiler is actually utilizing only 1000 tons of coal, but at 60 per cent efficiency it utilizes 1200 tons (.60 × 2000).

Or, let us assume that the modernizing of a given boiler will increase the efficiency of the boiler from 60 to 70 per cent. At 60 per cent efficiency, the boiler will burn 1666⅔ tons of coal annually, but at 70 per cent efficiency only 1429 tons will be required—a saving of 238 tons.

These two examples show that the lower the efficiency of the boiler the greater is the saving effected by the process of modernization and the higher the dividend on the investment. Thus if the efficiency of a boiler could be increased a little every day, a point would eventually be reached where it *wouldn't pay* to continue to increase the efficiency. There always is an efficiency that is "just right."

Let me emphasize though that this chart does not apply to boilers that are improperly operated. Every experienced boiler operator knows that he can create a low chimney gas temperature by using an excessive amount of air—by allowing excess air to filter in through the setting, etc. Such a boiler, according to my chart, would be efficient, whereas as a matter of fact it would be very inefficient. * * *



—PERSONALS—

E. W. McNealy has been appointed assistant superintendent of The Texas Company's new Eagle Point Works at Westville, New Jersey.

McNealy began his career with The Texas Company as a summer employee at the Port Arthur, Texas, refinery. After his graduation from Rice Institute in 1932, he was permanently employed at Port Arthur as a chemist. He served in this capacity and as assistant foreman except for a short period at the Beacon, New York laboratories. In 1939, he was transferred to San Antonio as a process engineer. In August 1949, McNealy was appointed assistant superintendent of the company's Casper, Wyoming, Works, a position he held at the time of his recent appointment.

R. R. Gumaer, assistant manager of the Pan-Am Southern Corporation's El Dorado, Arkansas refinery, was recently named technical assistant to the vice president in charge of manufacturing. His headquarters will be in New Orleans, Louisiana.

Joseph F. Orlovsky has been named supervisor at Esso Standard Oil Company's Bayonne, New Jersey refinery-process office. **Robert L. Albright** has joined the company as chief engineer at the Pittsburgh Grease Works. He succeeds **Albert B. Knight,** who was transferred to the Bayway refinery, Linden, New Jersey.

Arnold Belchetz

Dr. Arnold Belchetz, formerly chief technologist for Shell Petroleum Corporation and later head of the new processes department M. W. Kellogg Company, is now practicing as a consultant to the petroleum and chemical industries. Belchetz was at one time director of research and development for Stauffer Chemical Company. His consulting offices are at 125 Woodbine Avenue, Larchmont, New York.

Eugene C. Carlson was recently elected recipient of the first annual Cecil Award by the Tulsa Chapter, American Institute of Chemical Engineers. Carlson received the award for his paper, "Octane Requirements of Present and Future Automotive Engines," presented at the September 1949 meeting. He is a member of the research department of Stanolind Oil and Gas Company.

C. A. Thorn, plant superintendent for Phillips Petroleum at the Camp plant in Oklahoma City, Oklahoma has retired after 26 years with the company. He will devote his entire time to a farm at Cassville, Missouri.

E. O. Mattocks has joined the staff of the American Petroleum Institute in New York, in charge of engineering and research services, part of the new Technical Services Department headed by **D. V. Stroop.** A Cornell graduate, Mattocks has wide experience in the petroleum and gas industries, joining Phillips Petroleum Company in 1937 as industrial gas engineer, progressing to technical representative of the chemical engineering company, since 1942.

H. W. "Hi" Camp, one of the real pioneers in the oil refining industry, has completed a third of a century with Cities Service Oil Company (Delaware), as manager of its refining division. Known throughout the industry as a leader in the construction and operation of refineries, he has seen the technology of the industry grow from the simple straight distillation methods of 1917, to the highly catalyzed processes employed today. In 1917 he joined Cities Service as that far-flung organization was building its refining division to handle Kansas crudes just being brought into production at El Dorado. Camp was one of the pioneers in introducing different methods and processes, such as modern principles of fractionation, into the industry.

His outstanding contribution to the industry, without doubt, is a trainer of men. A long list of present-day leaders in refining have had graduate or post-graduate work under Hi Camp; 'Louie' Mann (Cities Service Refining manager); 'Jerry' Simpson (Cit-Con Corporation, vice president); Walter Scheumann, (Cities Service laboratories), and a long line of other refiners and technologists have played on his team. During World War II he

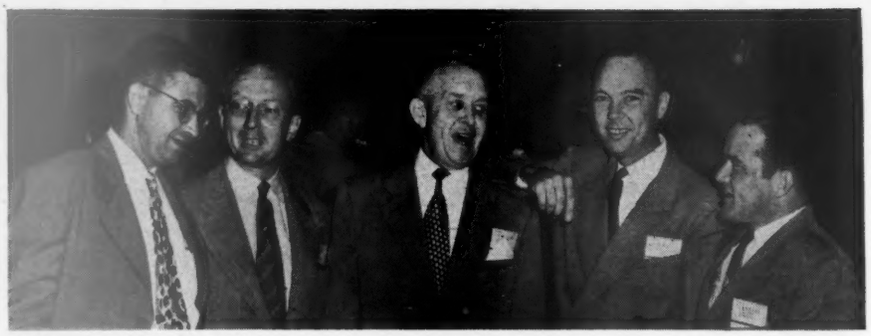
H. W. "Hi" Camp

was active on a large number of war committees dealing with problems of petroleum product supply to the armed forces. He is a member of the American Petroleum Institute, the Western Petroleum Refiners Association, American Society for Testing Materials, and other organizations. He and Mrs. Camp have four children, two sons and two daughters.

Hi Camp is retiring from active duty on September 1, but has agreed to remain in an advisory capacity to his company, especially prompted in this by the prospects of the development of war conditions.

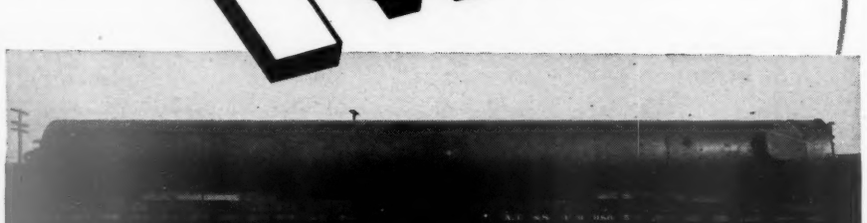
Lee N. Haugen will succeed Camp as manager of the refining division. Haugen, who has been general superintendent since 1947, has been employed by Cities Service 27 years. During this period his work has been devoted entirely to refinery operations. Following his graduation from Iowa State College, Haugen has been associated with Cities Service as a junior engineer, refinery cost engineer, general foreman at the Ponca City, Oklahoma refinery, and manager of the East Chicago, Indiana refinery.

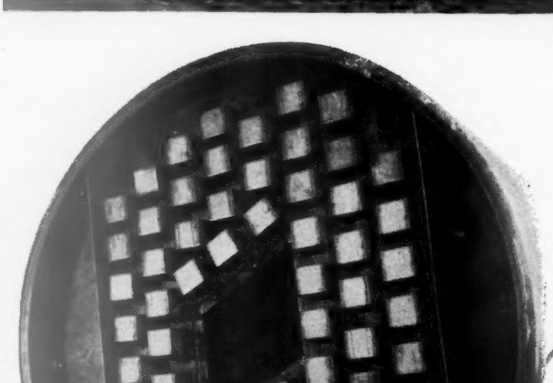
Lee N. Haugen



Attend NGA Meeting. Members of the Elliott Company staff who recently attended the Natural Gasoline Association of America meeting in Fort Worth, Texas are: R. L. Henry, field engineer; Tulsa; J. A. Wilson, field engineer, Dallas; J. N. McClure, district manager, Tulsa; J. D. Willcox, district manager, Houston, and G. J. Greaney, field engineer, Houston.

TULSA TYPE





TULSA TYPE Bubble Towers are BUILT RIGHT to accomplish the processing function required.

The staggered arrangement of the bubble caps prevents channeling of the liquid on the tray.

TULSA TYPE Bubble Towers, ranging in diameter from 12 inches to 13½ feet, are now giving successful performance in natural gasoline plants, oil refineries, butadiene plants and chemical processing plants.

WRITE FOR GENERAL CATALOG

FLINT STEEL CORPORATION

TULSA, OKLAHOMA

▸ **C. J. Gardner,** assistant superintendent at Sinclair's East Chicago refinery, has been transferred to the Wellsville, New York refinery as assistant superintendent. Gardner, who was formerly superintendent of Sinclair's refinery at Coffeyville, Kansas, succeeds **C. W. Hardell** at Wellsville.

Hardell was process superintendent for Sinclair Rubber Inc. at Houston prior to its shutdown in September, 1946, and he is returning to make ready for resumption of operations.

George A. Blaine, who has been in charge of the technical department at East Chicago, has been appointed assistant superintendent.

L. R. Bunger, formerly assistant to Blaine, will succeed as head of the technical department at East Chicago.

▸ **E. K. Lewis** has been appointed superintendent of the new 10,000-bbl per day refinery now being built by Imperial Oil, Ltd., at Winnipeg, Manitoba, Canada. Lewis was formerly superintendent of the Montreal East refinery, under the general superintendent, **A. C. Harrop.**

▸ **Michael H. Nolan** has been named general superintendent of Sinclair Refining Company's newly acquired refinery at Wood River, Illinois. Prior to joining the Sinclair organization

Michael H. Nolan

in 1934, Nolan was with the Producers and Refiners Corporation (a subsidiary of the Prairie Oil and Gas Company).

He was appointed superintendent of the refinery at Sinclair, Wyoming in 1938, a position he held until his transfer to Wood River. A graduate of the University of Notre Dame, Nolan was employed in the oil fields of Illinois for a short period and subsequently worked in various phases of the refining industry until he joined the Producers and Refiners Corporation in 1918.

Nolan and his family have been associated with the oil industry almost since its beginning. He is a member of API.

▸ **E. J. Karle** was named superintendent of the Barber, New Jersey refinery for California Refining Company.

Modern Dispatching on Natural Gas System

United Gas Pipe Line Company provides an example of present day use of equipment and methods that involve telemeter and remote control instruments.

FRANK H. LOVE*

It is a far cry, as the expression goes, from the early days of pipe line dispatching with its comparatively simple equipment and practices to those of the present day involving telemeter and remote control instruments that have placed control of pressures and volumes on a finger-tip basis. Nowadays when a dispatcher needs an increase or reduction in pressure or flow he has but to push a button. The simpler flow patterns of yesteryear have given way to more complex pipe line networks, and this, of course, has made necessary the employment of a greater number of instruments. Increasing demands for service, larger diameter and longer pipe lines, higher operating pressures, and closer integration of transmission facilities have all combined to make imperative a minute-by-minute knowledge of what is happening on a system and an on-the-minute control of whatever conditions may arise. As one veteran dispatcher expressed it in discussing the newer methods, "You know right now that your change has been made, and you can check results as they take place on a recording receiver instrument right here in the office. That is quite an improvement over having to call a station attendant by telephone, wait while he makes the change with manual controls, and then returns to the telephone to report results."

An excellent example of a modern dispatching system is that of the United Gas Pipe Line Company of Shreveport, Louisiana. Not too many years ago United dispatchers had only the telephone as a means of keeping them in contact with points of input, compressor stations, and centers of delivery and distribution. Telephone communication was sufficient in those days, and in some areas is sufficient even today. In most cases, however, a need has grown up for communications and control equipment to supplement telephone service. The complexity of the system has given rise to this need. Within recent years demand for natural gas service has grown. This means that the number of important delivery points has greatly increased. Discovery of new gas fields has added to the number of input points. Loop systems have been constructed and many inter-company tie-ins have been made.

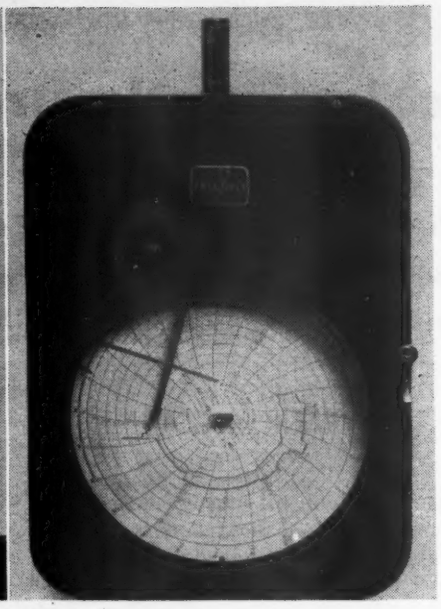
The beginning of United's modern communications system was begun the latter part of 1945. In that year radio was added. Fixed stations were installed at Carthage, Shreveport, and Sterlington, each installation including mobile units in company trucks and cars. Later, fixed stations were added at New Orleans and Lirette in the New Orleans district; at Bogalusa, Jackson, and Gwinville in the Jackson district, and at Iowa in the Southwest Louisiana district. An unattended radio station was installed at Arcadia, Louisiana, and at present two other radio installations are projected for

General view of building and grounds at New Orleans City Gate Station No. 2. Operations here are remotely controlled by dispatchers at City Gate No. 1.

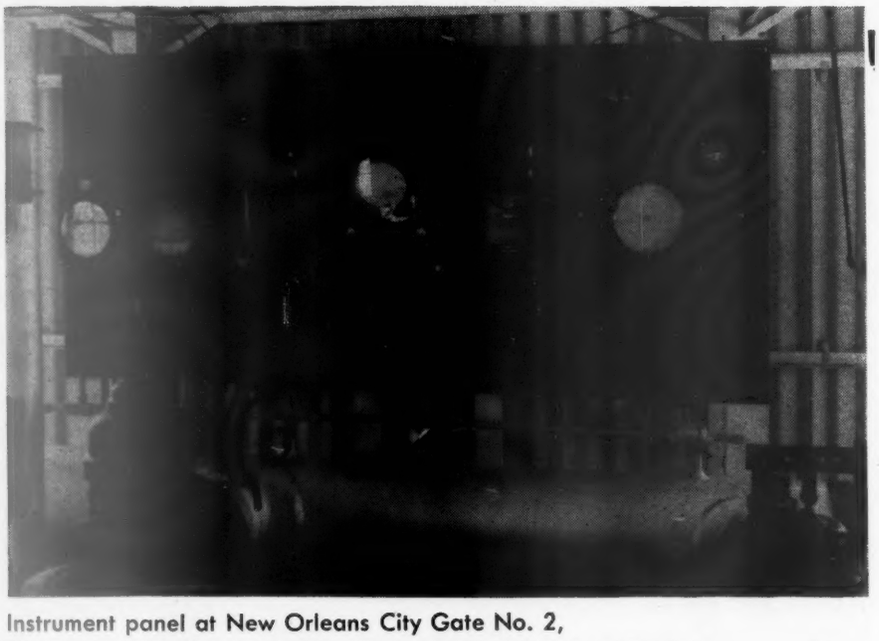
*Oil and Gas Pipelining Editor.

EXCLUSIVE

This metameter receiver records pressure on two lines and delivery on one line as transmitted by company wire between St. Rose and New Orleans.



With the small switch above this instrument, pressure and delivery changes are made remotely while the dispatcher watches results on the chart.



Instrument panel at New Orleans City Gate No. 2, showing metameter transmitters and remote control equipment.

the New Orleans district. Mobile units only are operating in the Houston and San Antonio districts and will be installed this year in the Wichita Falls district.

Now, supplementing telephone and radio are telemetering and remote control equipment. The latter have not been a matter of "overnight" acquirement, or even the acquirement of a few years, however. A pressure recording telemeter was placed in service at Bogalusa in the early 1930's, and soon thereafter a differential recorder was installed at the New Orleans Gate to register deliveries to Louisiana Power and Light Company. The Ford Street meter and regulator station in Shreveport has had telemetering since 1937. Similar equipment has been in operation at a number of other points, such as Conroe, Clinton, Longview, Carthage, Mobile, Pensacola, Mount Olive, and Jackson. Remote controls, also, have been in use in some individual compressor stations, as well as in gasoline plants. It has only been within comparatively recent months, however, that installations like those in the New Orleans, San Antonio, and Beaumont districts have demonstrated their full value in maintaining dependable service under present day conditions. A description of the equipment and its operation in these three districts follows:

New Orleans District

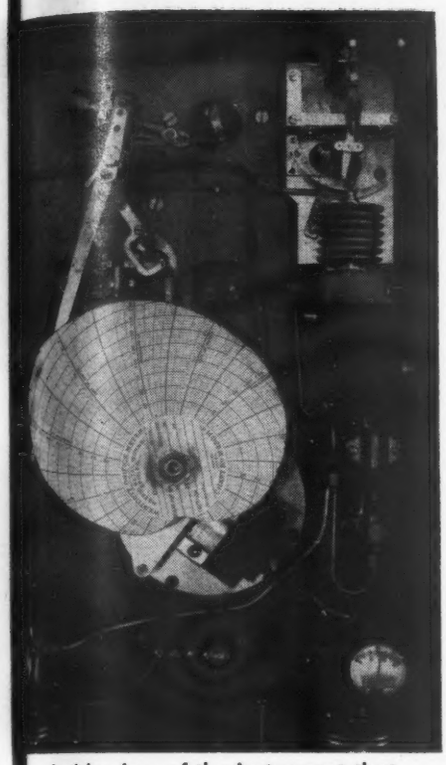
The central control point in the New Orleans district is at City Gate No. 1 where the district dispatching office is situated. Metameter receivers provide a continuous record of pressure and flow conditions. Here, also, is the control switch by means of which operations at City Gate No. 2, on the opposite side of the city, are controlled remotely.

At St. Rose, upriver from New Orleans, where lines from Lirette, Lake Long, DeLarge, and other producing fields cross or tie into the Baton Rouge-New Orleans main line, there are three metameter transmitters, which transmit pressure and differential on the Lirette-Mobile line and pressure only on the New Orleans line. The pressure transmitters are equipped with a cycle timer, switching from one pressure to another every 7½ minutes, and therefore requiring only one pen on the receiver at City Gate No. 1. The St. Rose metameters use two carrier telephone circuits on the Baton Rouge-New Orleans telephone line. One circuit is for pressure transmissions, the other for differential on the Mobile line. At St. Rose also are two telephone carrier transmitters. One two-pen receiver for recording pressure and differential, and two telephone carrier receivers at City Gate No. 1 complete the St. Rose installations.

Telemeter, radio, and telephone communications are all used to transmit pressure and delivery readings on the Lirette-Mobile line. The dispatcher at New Orleans City Gate receives both readings by metameter from St. Rose. These he relays by radio to Bogalusa, Gwinville, and Jackson. From Jackson they are telephoned on the company line to the general office dispatcher at Shreveport.

At New Orleans City Gate No. 2, there is an instrument that transmits downstream pressure and volume of gas going into the New Orleans Public Service Company's system, a differential flow controller operated by remote control from City Gate No. 1, and a manually operated auxiliary regulator set that maintains a pressure of 50 psi in event of failure of the remote control equipment.

At City Gate No. 1, a two-pen re-



Inside view of the instrument that changes the delivery of gas as required by the dispatcher.

ceiver records pressure and differential readings from City Gate No. 2, which can be changed as desired by means of the two-way control switch. Equipment at the two city gate stations is operated by two leased wire circuits.

Pressure and differential on the Barataria line are transmitted from Aurora, across the Mississippi River from New Orleans, to a recording receiver at City Gate No. 1. A single leased circuit operates this equipment. Such readings are necessary for the purpose of controlling the volume of gas from producing fields serving the Barataria line.

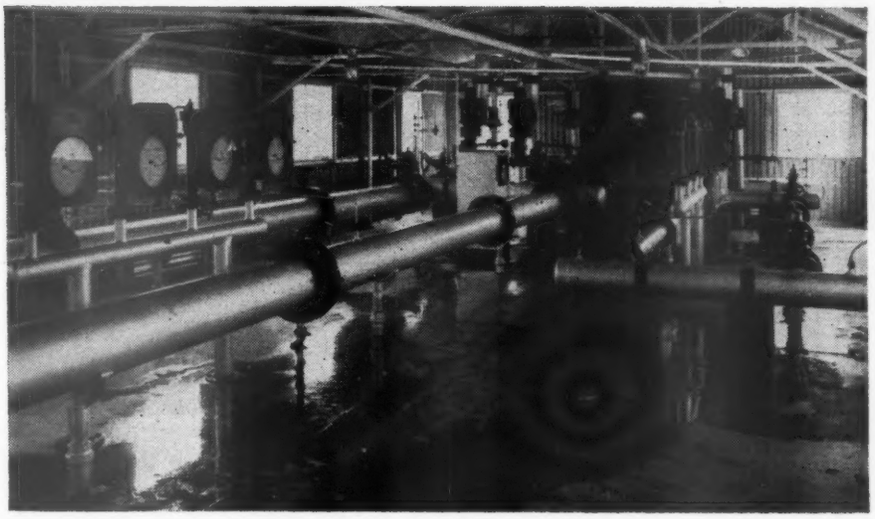
Constant pressure on the Barataria-New Orleans main line is maintained by a manually operated pressure control. The California Company, with 8 gas wells and a large volume of flare gas from oil wells, has a 9-mile, 12-in. gathering system and delivers gas to United at Barataria Common Point. Each gas well flow line into the gathering system is controlled by a regulator. When pressure drops the regulators open, turning the well on to hold pressure on the gathering system. When the pressure is rebuilt to the required point, the regulators shut off the wells.

Flow into United's line is maintained, from hour to hour, at or above the volume of flare gas. Should this not be done, pressure would build up in California's system and cause the flare gas to be vented to the air. The flow from the Barataria line is controlled by the dispatcher operating the remote control switch at City Gate No. 1. Additional telemeter and remote control equipment are to be installed in the New Orleans district, made necessary by the recent completion of a 16-in. St. Rose-Bayou Barataria tie-over.

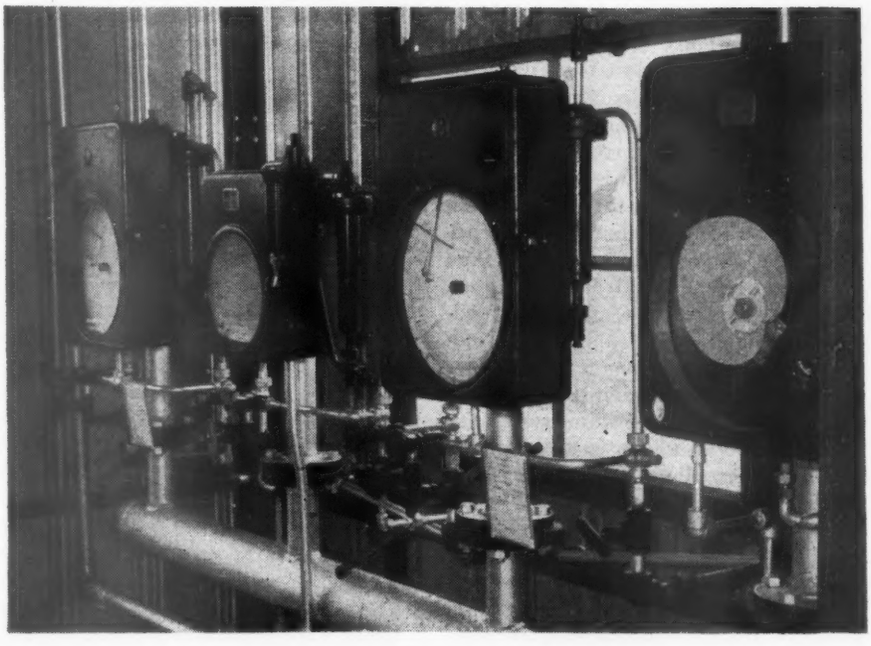
Beaumont District

In the Beaumont district is an example of remote control in a very true sense. By an arrangement of remotely controlled facilities, the flow of gas from Southwest Louisiana into the Beaumont district system at Call Junction is controlled from the district dispatching office at Nederland. As Nederland is approximately 50 miles from Call Junction this represents a near approach to automatic dispatching. The dispatcher at Nederland, of course, must know the pressures on the Southwest Louisiana 14-in. line and on the Magasco-Port Neches line, and he must have means of making changes in the setting of the regulator that controls the flow from Southwest Louisiana into the Beaumont district

Interior of New Orleans City Gate No. 2 meter and regulator station.

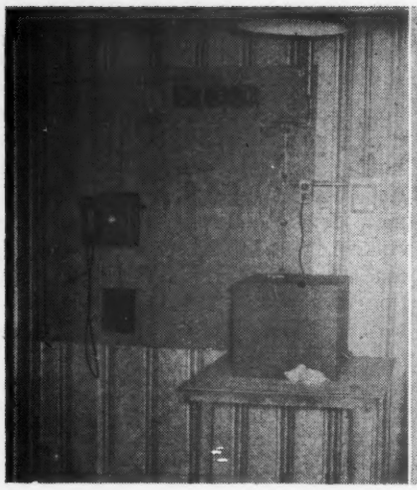


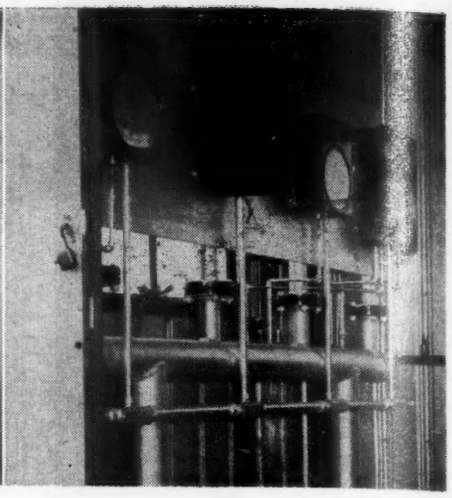
Telemeter and remote control equipment at Converse Junction in the San Antonio district.



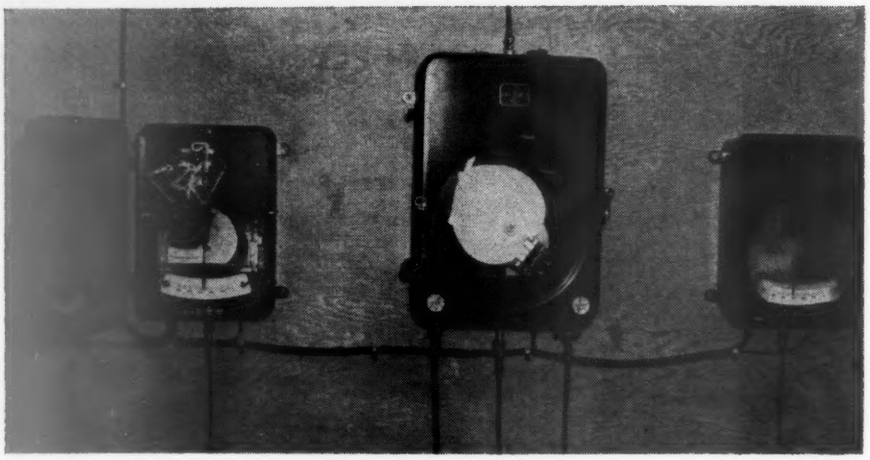
Right—By shift frequency carrier and cycle timer, pressures are transmitted from North Junction to San Antonio dispatchers at 5 and 10-minute intervals.

Far right—North Junction transmitters and remote control facilities.





Metameter transmitters, left and right, and the remote controller at Call Junction in the Beaumont district.



system. The required pressures are provided him by metameter sending units installed at Call Junction. One unit is installed upstream from the regulator on the Southwest Louisiana 14-in. line, and another downstream from the regulator on the Magasco-Port Neches line.

Carrier circuits were installed on existing company telephone facilities to transmit the electrical impulses from Call Junction to Nederland and change them into readings on a chart. The receiving unit in the Nederland office has two recording pens, one for upstream and one for downstream pressure. The pens operate independently of each other and are controlled by a gear-train on an electromagnet.

With the required pressure readings provided, the dispatcher at Nederland next needs a means of changing the rate of flow through the regulator as pressure changes become necessary at Call Junction. This is provided by a Bristol Ampliset Free Vane Controller used in conjunction with a 10-in. Emco regulator and conventional Foxboro motor lever to actuate the flow. The controller maintains the necessary pressure on the motor lever to keep a constant downstream delivery pressure regardless of the volume of gas being delivered.

An important feature of the Call Junction control equipment is that once a setting is made, it is maintained continuously until a new setting is required. The advantage of this lies in the assurance that, in the event of interruption to communications, the latest recorded pressure at that point will remain constant until the communications emergency has been removed.

San Antonio District

Telemetering and remote control regulation have been in use in the San Antonio district about a year, having been inaugurated as a part of the company's expansion program at that time. The equipment is operated from the district dispatching office at South Junction, and resultant pressures and flows are recorded on receiving instruments installed in the same office.

Metameter and remote control equipment are in service at Converse. At that point a new 20-in. line forms a junction with the old Pettus-Converse 16-in. line, and a new 20-in. extends 5 miles west to connect with the Bruni-Comal 18-in. line and new 16-in. loops. A two-wire telephone circuit was constructed parallel to the new 20-in. line from Converse Junction to North Junction and extended to South Junction over Western Union poles. By means of this circuit the regulators and meters are remotely operated.

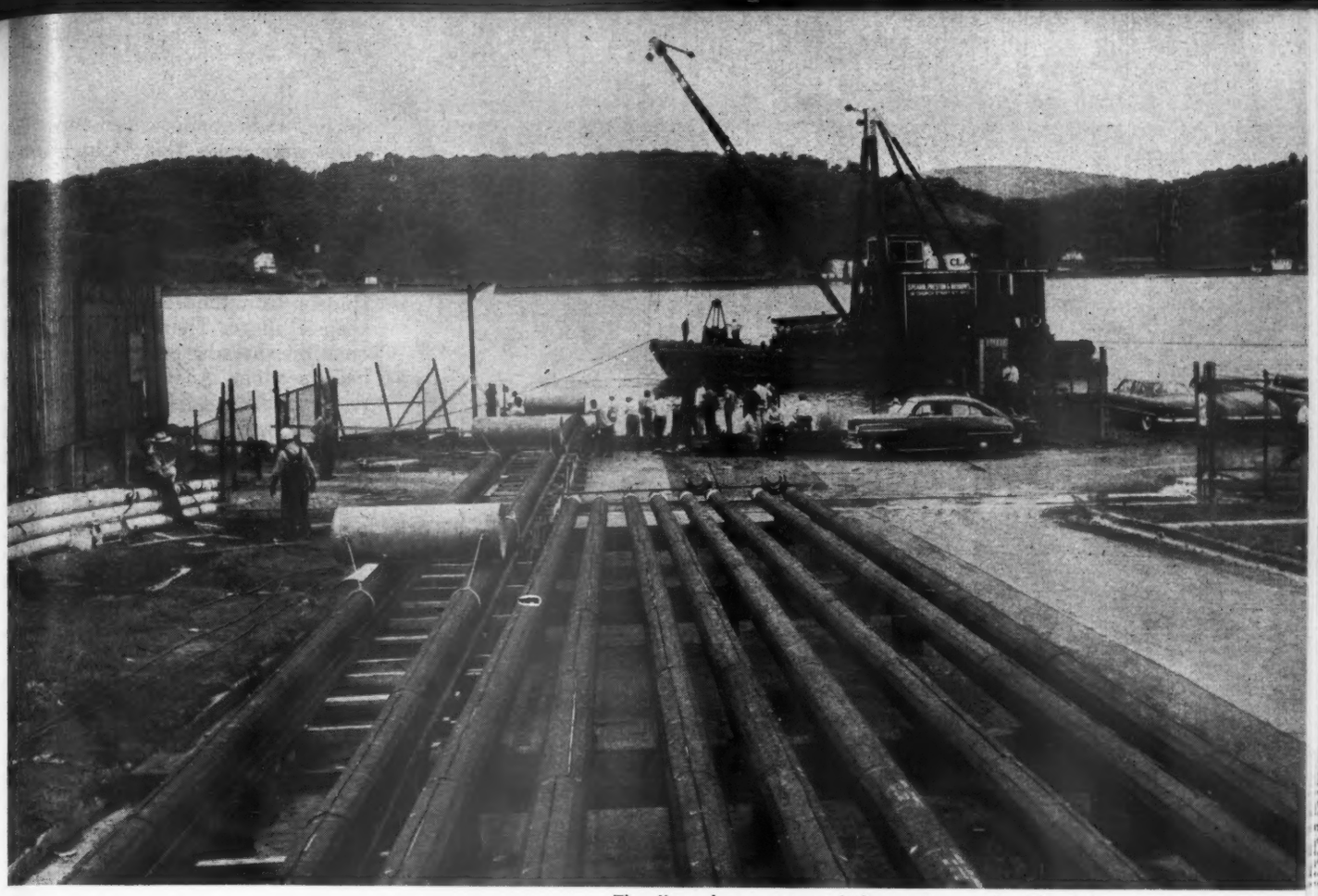
At Converse Junction, the equipment is operated entirely by shift frequency carrier. This consists of a remotely controlled regulator that controls pressure and flow from the Burnell-Converse 20-in. line into the Converse-New Braunfels 16-in. line, for gas deliveries to Austin and intermediate points. The meter differential pressure for this flow is transmitted to a receiver at the South Junction dispatching office, and by use of a cycle timer, upstream and downstream pressures are transmitted at 5 and 10-minute intervals to another receiver also situated at South Junction.

Another remotely controlled regulator is also in service at Converse Junction to regulate flow from the Burnell-Converse 20-in. line into the Converse Junction-North Junction 20-in. line, which now supplements the gas supply from the old Pettus-Converse 16-in. line.

At North Junction, a remote control, simplex-operated regulator controls pressure and flow from the Converse Junction 20-in. into the South Junction-Comal 18-in. line and the new 16-in. loop line.

Upstream and downstream pressures at this point are transmitted at 5 and 10-minute intervals to the district dispatching office at South Junction by shift frequency carrier and a cycle timer.

Thus, over a period of a few short years, United Gas Pipe Line Company has installed equipment that represents a complete transition from early day methods to a modern streamlined system of dispatching. * * *

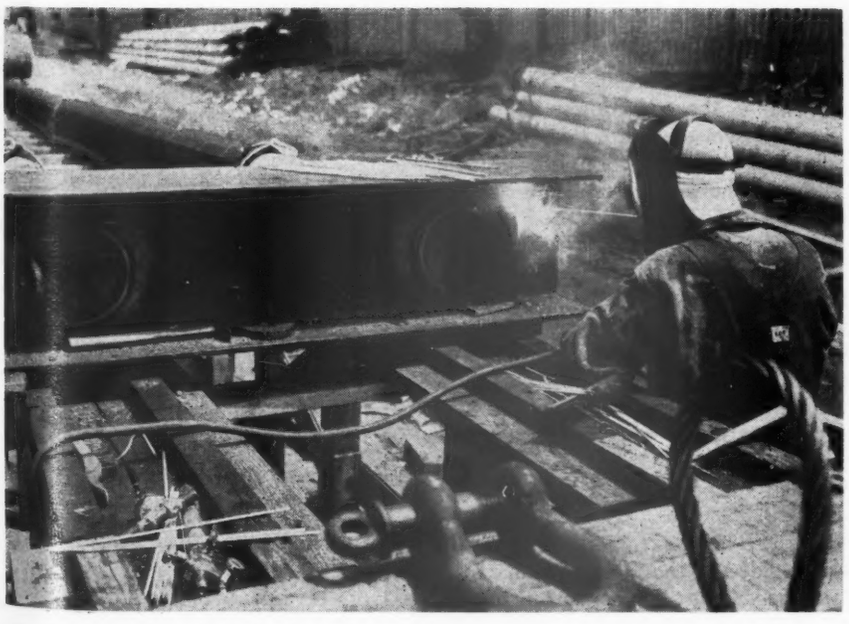


The lines have entered the water and a derrick on a barge guides them out along the river as they start their trip to opposite shore.

P 623.91

Gas Pipe Line Crosses Hudson River

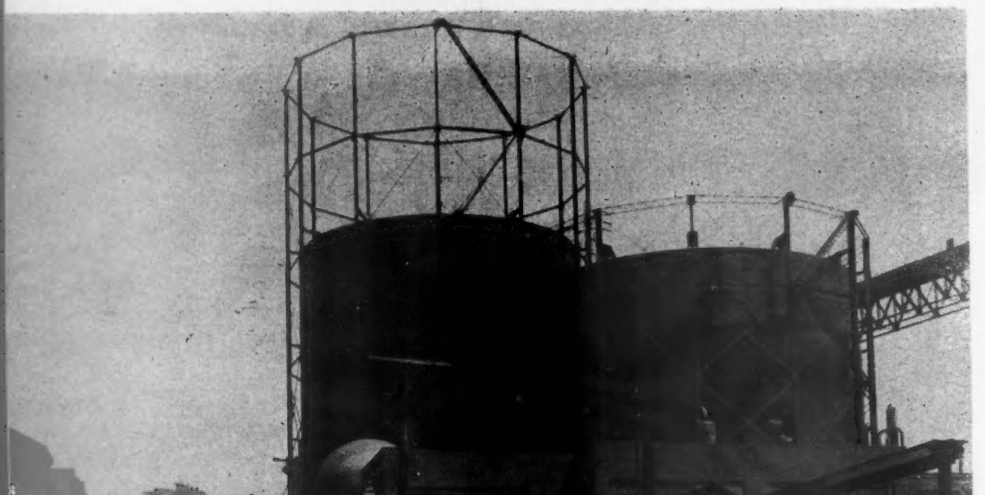
GEORGE H. LANDIS*



THE first crossing of the Hudson River by natural gas pipe line was made recently by the Central Hudson Gas and Electric Corporation of Poughkeepsie, New York. Two 2600-ft 8-in. pipes were pulled together across the Hudson from Poughkeepsie on the east bank to Highland on

*Chief Engineer, Central Hudson Gas and Electric Corporation.

The final welding operation is completed on the I-beam spreader that keeps the dual lines separated for their underwater passage. The 8-in. lines are welded in position approximately 3 ft apart and rest on the skidway that guides them to their starting point on the Hudson's west bank.



An over-all view of the pipe lines ready for the crossing. In the background are the company's holders for gas. The pipes on the right are the first to go and already have tanks attached to increase their buoyancy when they enter the water.

the opposite shore. This closed the last gap in a $2,000,000 40-mile natural gas line extending north from a connection with a Columbia Gas System line near Tuxedo, New York, and terminating at the company's main gas works in Poughkeepsie.

The Poughkeepsie-Highland underwater operation was the most critical faced along the entire 40-mile pipe line route. At its deepest point, the river bottom lies 65 ft below the surface and as the pipe was dragged the width of the river it had to run hazards of tide, current, surface vessels, logs, and the mud and rock bottom. A further complication was the fact that two pipes were pulled at once.

The pipe used was extra heavy API-5L electric weld in 40-ft sections with an outside diameter of 8.625 in. and a wall thickness of 0.375 in. In the field the 40-ft lengths were welded into 600-ft sections and the joints were wrapped by hand. In addition, to afford mechanical protection during the pulling operation, the entire line was given a final field wrapping of 3/16-in. rock shield banded on with steel straps.

All pipe was tested hydrostatically at the factory for 1800-psi pressure and in the field for 600 psi. The maximum operating pressure of the line will be about 300 psi.

The 600-ft twin sections were welded on wooden supports parallel to a twin skidway leading to the water. The first sections were then lifted by crane off the supports and on to the skidway where they rested on heavily greased wooden shoes placed at 40-ft intervals. The natural incline of the hill lessened pulling strain considerably. A steel cable attached to the tail end of the twin sections was held by a motor-driven crane at the top of the street to keep the pipes from running away. After the first twin section was pulled into the water, the next twin section was lifted off the wooden supports and on to the skidway.

A spreader cut from a 14-in. I-beam and welded to the pulling ends of the two pipes kept them separated by 3 ft during their underwater trip. The pipes were made watertight by steel plates welded over their ends.

At the start of the operation, a barge equipped with a steam winch anchored near the Highland shore. A cable was carried by boat across the Hudson from the winch to the Poughkeepsie shore. There it was hooked on to the spreader attached to the first twin section. Another barge stood ready on the Poughkeepsie shore with a steam winch to support the front end of the pipe so that it would not dig into the river bottom as it crossed.

The winch at Highland slowly pulled the first twin 600-ft section, weighing almost 40,000 lb down the greased skidway and dragged it out about 575 ft along the river bottom. Two more 600-ft lengths were transferred from supports to the skidway, welded to the exposed end of the pipe on the river bank, and then pulled into the river. This procedure was repeated until all the twin sections were joined and the two long pipes emerged on the Highland shore.

Because of their great weight, the twin pipes are not anchored. They will hold their position against the strongest tides and currents and the great depth of the river will protect them from severe temperature changes.

About 1000 ft from the Poughkeepsie shore of the river, the new natural gas line crosses an older 8-in. manufactured gas line. Great care was exercised during the pulling operation to protect the older line. At the crossing point an 80-ft casing of 14-in. pipe, split lengthwise, was placed over the manufactured gas line. This shell-like covering was then filled in from the river bottom mud and silt.

The pulling operation was carried on only during daylight hours and took about three days. Actual pulling time, however, was less than 5 hours since the pipe entered the water at the rate of about 10 ft per min.

When the entire job was done a diver inspected the 2600-ft connection and at the same time released the 85-gal steel tanks attached to the pipes.

* * *

Highest Pipe Line

One of the world's highest "big inch" gas-transmission lines is that in the Rocky Mountains from Salt Lake City to Coalville, Utah. Starting from an elevation of 4500 ft, the line climbs to an 8000-ft elevation, through sharp canyons, to Parley's Summit. It then winds down the mountains to Coalville, 32 miles away, at an elevation of 5500 ft.

New Method for Bulk Modulus Determinations*

Surge Wave Velocity Is Affected by the Physical Characteristics of Liquid, Making Bulk Modulus Data Desirable in Addition to That on Specific Gravity and Viscosity

S. LOGAN KERR[1], LEWIS H. KESSLER[2], MERRILL B. GAMET[3]

Part 1

In any computations concerned with so-called "water hammer" or surge conditions occurring when the flow rate of a liquid is changed in a closed conduit, the compressibility of the liquid and the elasticity of the conduit walls have a major effect upon the magnitude of the surge, as well as its distribution along the conduit.

The magnitude of the surge is directly proportional to the velocity of the surge wave and this, in turn, is affected by the diameter, thickness, materials of construction, and modulus of elasticity of the pipe walls. The character of the liquid in the pipe line also enters into the conventional equation for surge wave velocity, with both specific gravity and compressibility affecting the values. The conventional formula for surge wave velocity is as follows:

$$a = 12 \Big/ \sqrt{\frac{w}{g}\left(\frac{1}{k} + \frac{d}{Ee}\right)} \quad . \quad (1)$$

Where:

- a = velocity of the pressure wave in feet per second.
- w = weight of 1 cu ft of liquid in pounds.
- g = acceleration due to gravity in feet per second.
- d = diameter of the pipe, inches.
- e = thickness of pipe walls, inches.
- k = bulk modulus of compressibility of the liquid, psi.
- E = modulus of elasticity of the material of the pipe walls, psi.

The specific gravity under various temperatures and pressures can be determined without great difficulty. The compressibility factor, more commonly expressed as the bulk modulus of compressibility, is not so easily arrived at.

The bulk modulus can be calculated as follows:

$$K = \frac{\Delta p}{\Delta V} V \quad . \quad . \quad . \quad (2)$$

Where:

- k = bulk modulus of the liquid, psi.
- Δp = pressure increment, psi.
- ΔV = volume increment produced by pressure increment Δp.
- V = original volume in same units as ΔV.

The bulk modulus value for water at ordinary temperatures and pressures has been reported in a number of publications and is commonly taken as 300,000 psi for most surge calculations.

The bulk modulus of fluids other than water has not been reported in engineering literature to any great extent, particularly in the range of pressures and temperatures ordinarily encountered in petroleum pipe line work (0 to 1500 psi, and 32 F to 100 F).

To make surge investigations in advance of construction of a pipe line requires some knowledge of the velocity of the pressure wave within the system for computing the magnitude of surges that might be expected due to ordinary routine operation or due to emergency conditions.

The physical characteristics of the materials and construction of the pipe line itself are fairly well known. The remaining factor relates to the physical characteristics of the liquid and it is to these matters that attention is directed in this paper.

Review of Literature

Some of the earliest work done on the determination of surge wave velocity in liquids other than water was in connection with the studies of fuel injection systems for diesel engines.

Unfortunately, the investigations were carried out at fairly high injection pressures in the range from 1000 to 6000 psi, or even greater, and very little information is available for pressures below 1000 psi. The variation of compressibility or variation of bulk modulus with temperature has also been investigated to some extent, but here, too, the experiments were conducted at pressures on the order of several thousand pounds per square inch and did not cover in detail the range in which petroleum pipe line designers are primarily interested. There is included at the end of this paper a brief bibliography listing some of the important references.

In most every case, the determinations have been made by measuring, as accurately as possible, the quantity of additional volume of fluid required to compress the initial volume of material to various pressures. The means of measuring the increment of volume are varied, and some of the apparatus used a precision measurement of the displacement of a piston and in other cases a mercury pump was employed.

Hyde[1] measured the position of a sleeve on a plunger (8 mm bore and 12 cm long) before and after the application of pressure and determined the decrease in volume of the liquid in the small cylinder having a volume at 15.56 ml. Tyrer[2] worked at not more than two atmospheres of pressure with soft soda-glass and copper compressibility piezometers of 500 ml capacity. He attempted to change the pressure and measure the volume change before any of the heat produced in compression had been lost.

LeMesurier and Standsfield[3] used device shown in Fig. 1. "A" is a steel cylinder with vent plug "B" and gland "C" fitted with a slow speed engine fuel pump piston "D" surrounded by split washer "E" at the outer end. "E" is held tightly in place with a spiral spring "F" surrounding the groove in the halves of the washer. Inner cylinder was filled with test fluid and low-

*Presented before joint Petroleum and Hydraulic Division Session, The American Society of Mechanical Engineers, St. Louis, Missouri, June 19-23, 1950.

[1]Consulting engineer, president, S. Logan Kerr and Company, Inc., Philadelphia, Pennsylvania.
[2]Professor, [3]associate professor, Civil Engineering Department, Northwestern Technological Institute, Evanston, Illinois.

[1]References at end of Part 2.

ered into the outer cylinder "G", which was filled with fluid at the same temperature as the sample. Outer cylinder was sealed by cap "H". Pressure was applied directly to oil in "G" and to plunger "D" and hence to sample in "A", the washer being in contact with outer end of gland "C" moved a distance proportional to the decrease in volume of test sample. When direct pressure was released, the plunger was forced out of the gland by the expanding sample and carried with it the washer. Measurement of movement on the washer allowed the volume change of the oil when under pressure to be calculated from known dimensions of the plunger. No dimensions of the device are given. LeMesurier assumed no strain in material of test vessel, because of balanced pressures, but Davies[3] states that there is a stress present, although LeMesurier believed it to be so small as to be negligible.

Talbott,[4] Fig. 2, used a copper tube screwed to the cover of a thin sealed vessel "A" and fitted with an insulated filling cup "B" at its upper end and a copper pot "C" at its lower end. A fine platinum wire was attached to the filling cup and passed a short distance down the center of the tube. The inner vessel was surrounded by a cylinder of adequate strength and the liquid to be tested was placed in the inner vessel and mercury was poured into the tube and copper pot to form a mercurial seal. The space between the inner and outer vessels was filled with distilled water, and hydraulic pressure was applied. This pressure was transferred through the mercury to the test liquid so that the inner vessel contracted in volume as a solid under hydrostatic pressure until the circuit was completed when the mercury contacted the platinum wire. The entire apparatus was surrounded by a water bath.

Cap "D" was removed and mercury added or removed until the electric contact was broken at atmospheric pressure. A weighed quantity and therefore a known volume of mercury was added to the filling cup and the pressure necessary to break the contact was found. The pressure was measured by an optical gauge and a lamp indicated when contact was broken. A telescope and scale were used for the pressure gage and the lamp was placed in field of view of the telescope.

Talbott's experimental results were corrected for decrease in volume of the containing pot, the compressibility of the mercury, and for rise in temperature due to compression because he applied maximum pressure in 10 sec.

The above experimenters used devices employing a thin wall test chamber and balanced the internal and external pressures, but apparently did not use dead weight testers for pressure application, or to determine unit pressure applied. In all of these instances, however, the volume and pressure increments were read when the apparatus was under pressure. Some question has been raised as to the accuracy of these measurements, particularly in relation to leakage from the apparatus, leakage past a piston or stuffingbox, or the displacement of the liquid within the pressure measuring device.

FIG. 1. Le Mesurier and Stansfield test apparatus.

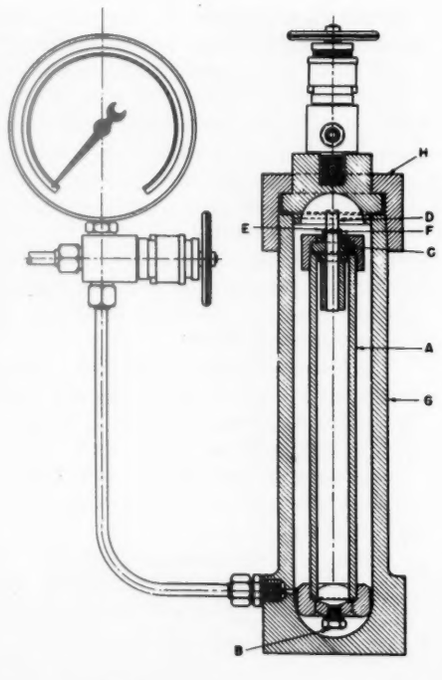
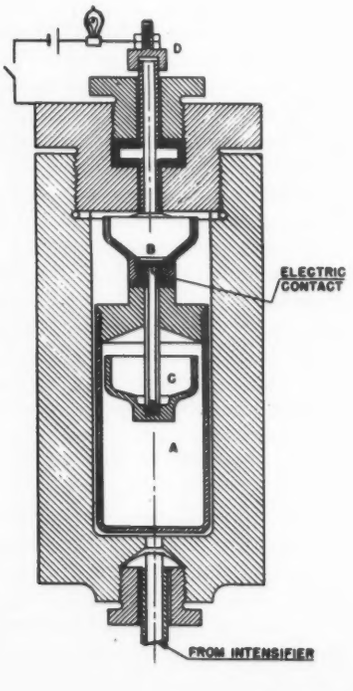


FIG. 2. Talbott test apparatus.



Joint Surge Conference

During investigations authorized by Joint Surge Conference, set up to study the surge conditions within petroleum pipe lines, particularly those carrying crude oil, the need for accurate data on the compressibility factor was immediately apparent.

Some determinations had been made experimentally, but it was finally agreed that an independent investigation would be desirable, to check the bulk modulus for the particular oils being transported under conditions existing during the field test work.

A conference was arranged between the 3 authors of this paper, to conduct a program of tests[a] in which the effect of variations of temperature and pressure on bulk modulus within ordinary ranges could be determined, using a small sample of the actual fluids flowing through test pipe lines. It was felt that certain basic design conditions for the apparatus should be fixed to avoid the potential errors believed to be present in the methods used in other investigations.

These fundamentals of design were as follows:

1. The apparatus should eliminate leakage or slip in relation to the measurement of the volume increment.
2. The apparatus should eliminate, as far as possible, any effect of volume change due to the pressure measuring device.
3. The apparatus should incorporate a dead weight gauge tester for basic pressure measurement and avoid the use of a Bourdon tube type pressure gauge, except for approximate indications.
4. The volume change of the apparatus itself under varying pressures and temperatures was also to be kept at a minimum.
5. The measurement of the increment of volume (ΔV) was to be made at atmospheric pressure and under conditions whereby this increment could be read to an accuracy of 1 per cent or less.
6. The overall accuracy of the bulk modulus determination at any given temperature or pressure should be within plus or minus 2 per cent on an

(a) These tests, made in 1949, were part of a program instigated by the Joint Surge Conference of individuals representing Middle East Pipelines Limited, Trans-Arabian Pipe Line Company, and Gulf-Shell Pipe Line. The test results are included in the "Final Report of Joint Surge Conference"[13], which has been made available to the national engineering societies and to interested individuals and companies.

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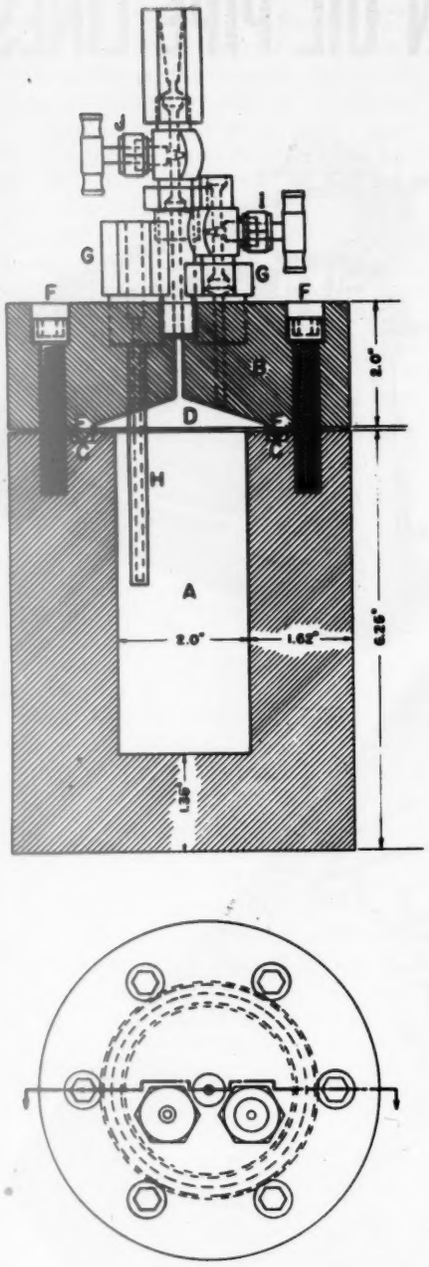


FIG. 3. Cross-section of test vessel.

weight gauge tester. The pressure was then constant throughout the system and by closing a valve it was possible to trap the total volume (initial V plus ΔV) within the pressure chamber.

The pressure was relieved by gradually opening a valve connected to a precision graduated micro-burette until atmospheric pressure was reached. The difference between the initial reading and the final reading on the calibrated glass tube represented the increment of volume released and thus gave the value of ΔV. The initial total volume "V" of the chamber was determined by dimensional measurement and also by a volumetric check to be 290 ml.

As the increment of pressure is from atmospheric up to the desired test value, the gauge pressure as determined by the dead weight tester represents ΔP in equation (2).

Description of Apparatus

A thick walled cylindrical steel pressure vessel "A" of Fig. 3 (5¼ in. OD and 2 in. ID) was machined with the top of the cylinder containing an annular slot "C" or mortise of rectangular cross-section to act as part of the seal for the test fluid. The inside bottom of the cap "B" was machined as a cone "D" of 2⅝ in. diam with an annular V-shaped tenon "E" machined to fit into the mortise of the cylinder without the tenon touching the upper corners of the mortise. Hard solder wire was cut, lapped and placed within the mortise. The "V" shaped tenon was forced into the solder by tightening six ⅜-in. stud bolts "F" so that a perfect fluid seal was formed. The design causes all entrapped air or gas to be forced out through the vertex of the cone.

To introduce fluid under pressure into the vessel, measure its temperature, and discharge compressed fluid upon release of pressure, suitable threaded adapters "G" with copper gaskets were fitted into the top of the cap with small holes extending through the cap into the pressure chamber. The small thermometer well "H" of stainless steel to contain thermocouple wire was first press-fitted into the cap.

A ¼-in. steel needle valve "I" was screwed into the inlet adapter and a second valve "J" was fitted to the relief adapter. At the top of the discharge valve, there was fitted a metal to glass adapter, machined and ground with a tapered hole to fit precisely the male end of a standard ground glass Pyrex tube.

Fig. 4 shows the general arrangement of the apparatus. The test vessel is mounted within a steel encased water bath having inlet water and drainage connections. A 750-watt immersion heater and thermo-regulator controlled the water bath temperature. A potentiometer was connected to iron-to-constantin thermocouple leads inserted in the temperature well.

To segregate the test fluid from the fluid in the dead weight gage tester, the inlet valve to the pressure chamber was connected by ¼-in. pressure transmission pipes to a "U" tube type mercury piston, one leg of which was a 2000-psi pressure chamber sight gage glass and the other leg a machined steel cylinder connected to a 5000-psi dead weight gage tester. Valves were

individual run and within plus or minus 1 per cent on a series of runs, using an average curve through the individual test points.

It was immediately apparent that with this basis for design, none of the apparatus described in the various technical publications could be used. A new design was therefore worked up to perform these experiments in a completely different way from that described in the literature listed in the bibliography.

Instead of measuring the quantity of liquid required to raise the pressure a given amount, by observing the displacement of a column of mercury or a piston, the new apparatus was arranged to build up the pressure to the desired value, as measured by a dead

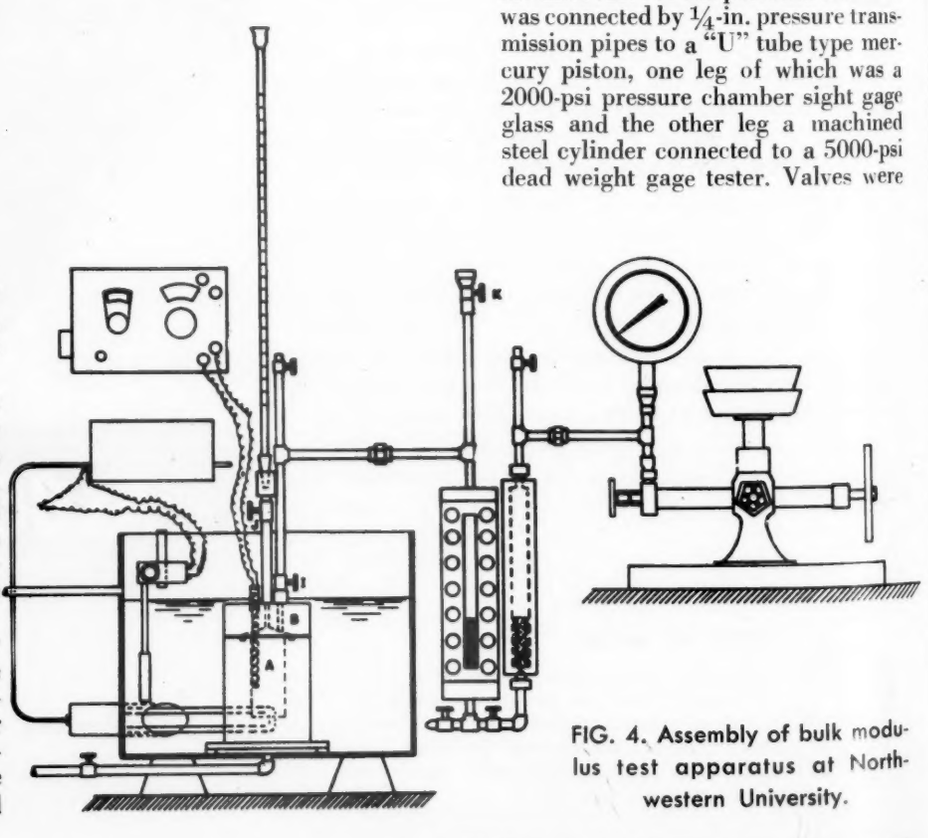
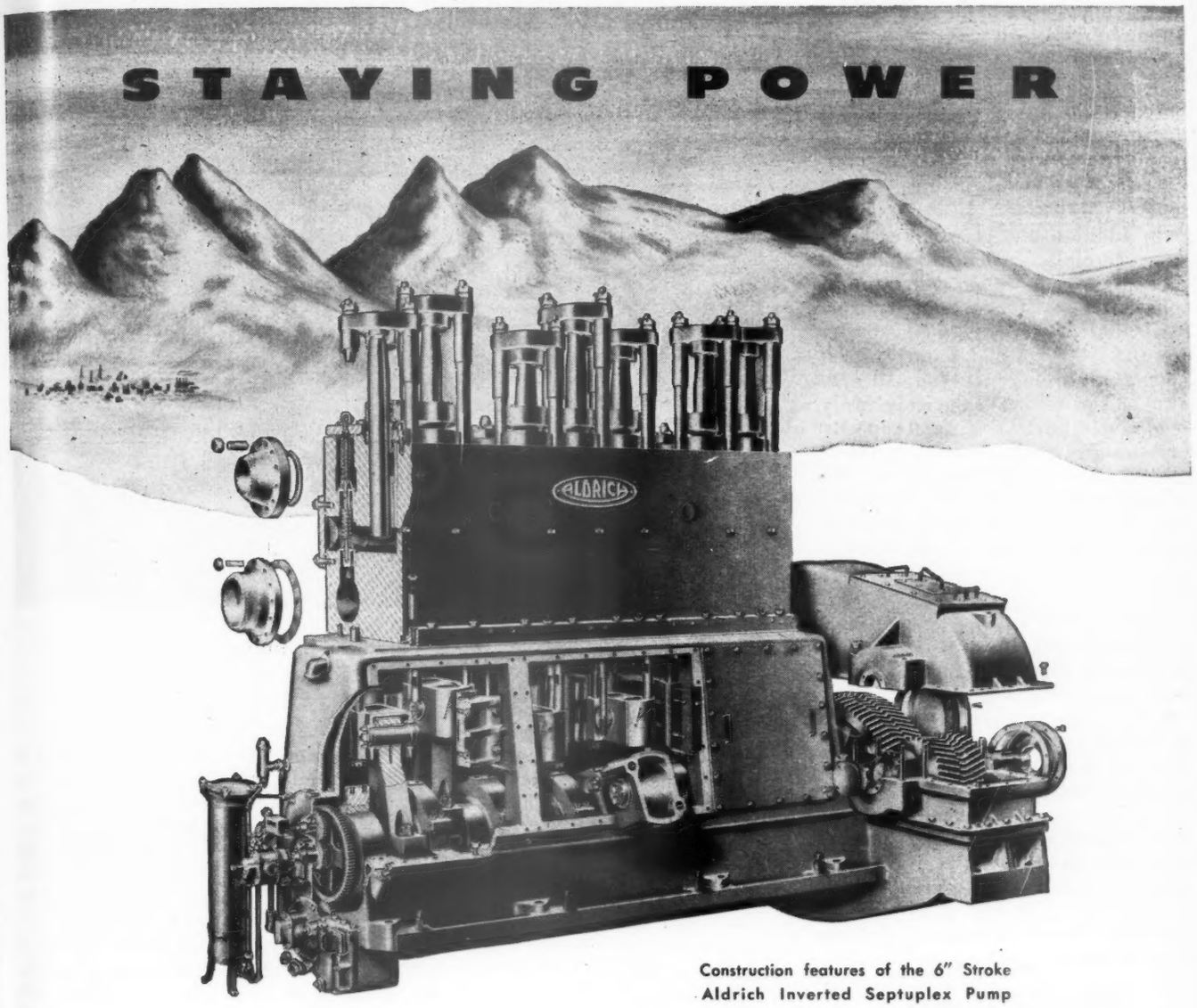


FIG. 4. Assembly of bulk modulus test apparatus at Northwestern University.

STAYING POWER



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used at high points of the transmission piping to release all gases or air from the system.

Three standard calibrated micro-burettes with pyrex tapered adapters of 2.0, 3.0, and 5.0 ml capacity, each reading to 0.01 ml, were used to determine fluid volume displacement from the test vessel.

In addition, the glassblower made from carefully matched serological pipettes, three other micro-burettes as follows: One of 0.2 ml capacity from two 0.1 ml; another of 0.4 ml capacity from two 0.2 ml, and a third of 2.0 ml capacity from two 1.0 ml. All were graduated to 0.01 ml and can be easily read to 0.001 ml. These small capacity burettes give great accuracy in determining small volume changes as a 0.1 ml displacement causes a $\frac{5}{8}$-in. rise in fluid level in the smallest diameter burette. Calibrations of all burettes were checked by volume with mercury.

Tests proved the steel valves and pressure transmission pipes were absolutely tight. One characteristic of all dead weight testers is that continuous rotation of the piston is necessary and that after a 30-min period, some oil from the tester slips by the piston up into the surrounding cylinder requiring adjustment of the hand wheel to maintain weights and pan at constant level. This in no way affects the magnitude of unit pressure exerted on the mercury piston of Fig. 4, as long as pan is not allowed to rest on top of the fixed cylinder.

Estimated Accuracy

Using Lamés formula as corrected by Clavarino for the determination of tangential and radial unit stresses in a thick walled hollow cylinder under internal pressure only, theory indicates that the maximum change in total volume of the test vessel of 0.0043 per cent would be practically negligible between 25 and 1500 psi maximum internal pressure. However, the opening of the gap between cap and cylinder at the seal needed investigation. Seven SR-4 electric strain gages were fastened to the test vessel, in such positions that radial, tangential deformations and opening of the gap were determined, in micro-inches per inch. According to theory radial and tangential stresses are zero at outside surface of the vessel and the tests confirmed this.

At 1500 psi there is 885 lb pull on each of the 6-bolts of the cap or 16,500 psi stress in the shank and the seal never leaked. The average increase in measured opening of the gap was 225 millionth of an inch. This is a displacement of the contents of the test vessel (290 ml) of 0.0108 ml or 0.0037 per cent. The total calculated change in volume of test vessel caused by all stresses is about 0.008 per cent or 0.79 per cent of the volumetric displacement in the micro-burette based on test results with gasoline.

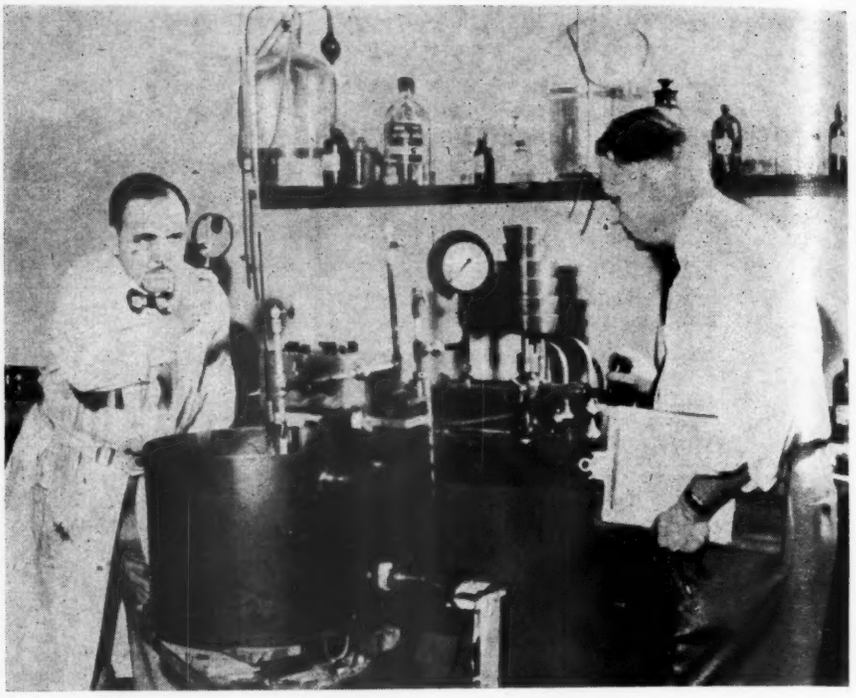


FIG. 5. Test apparatus in operation.

To be sure that the test vessel could be used without placing the vessel within an equalizing pressure chamber as would be essential for higher working pressures, confirmatory tests, described in detail later in this paper, were run to check values on the bulk modulus of distilled water free from dissolved oxygen as reported by other investigators. The values of the modulus for water came within the range of values determined by others, it is believed this new test device can be used to obtain bulk moduli with errors not exceeding 2 per cent on any liquid during an individual run at the highest test pressure of 1500 psi.

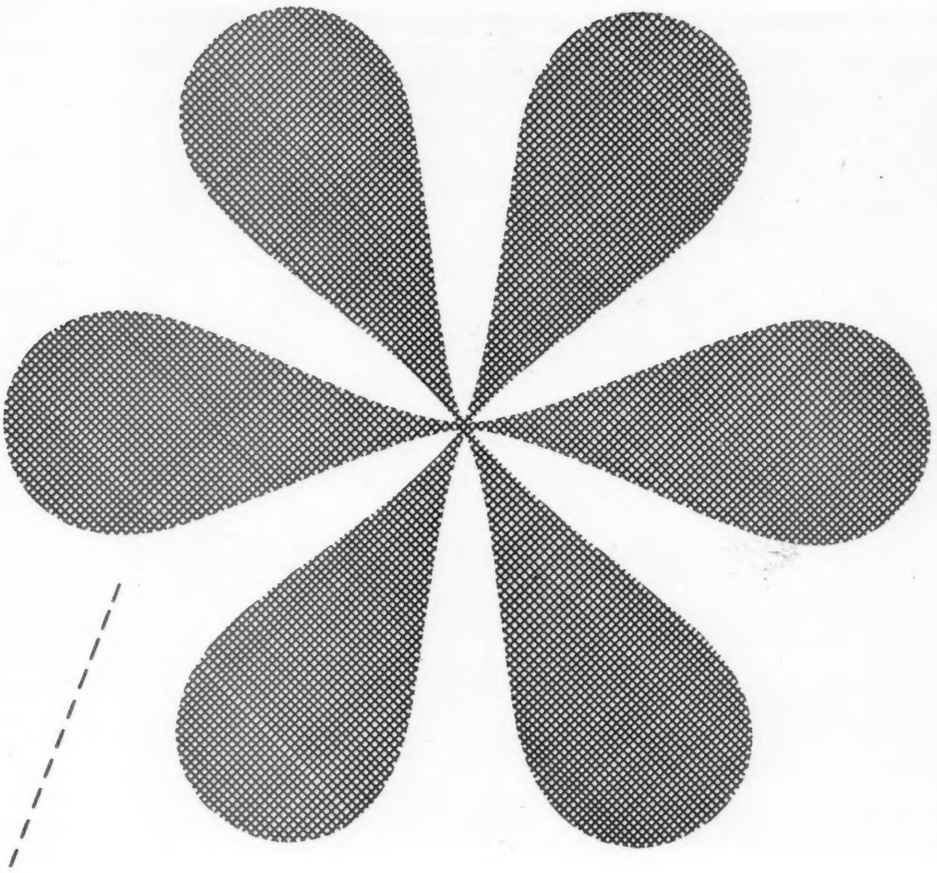
Test Procedure

Fig. 5 shows the apparatus under simulated test conditions. Before undertaking a series of runs, the test vessel is thoroughly cleaned with carbon tetrachloride and the lower portion of the cylinder filled with the fluid to be tested. A dry rag is used to wipe a thin film of mercury onto the surface of the "V"-shaped lead seal. The cap is connected to the cylinder tightly so as to withstand 2000 psi and the remainder of the cylinder and conical dome is filled with fluid. The vessel is placed in the water bath and transmission pipes are connected as in Fig. 4. The fluid and the test chamber are brought to uniform test temperature using either ice or heated water. It may take 30 or more minutes before the temperature levels off and during this time the fluid temperature is read by the potentiometer.

Mercury is placed in the bottom of the "U" tube and pipes connecting the leg to the test vessel are filled with fluid. A medium weight lubricating oil is used in the dead weight tester, the connecting piping, and the leg of the "U" tube away from the test vessel.

A pressure of a few psi is placed on the system. Bleeder valves are opened to flush out all entrained air or gases and are then closed. One of the calibrated pipettes of suitable volume for the estimated displacement of test fluid is selected. The ground tapered joint is greased with a solvent resistant stop-cock grease, and is heated slightly before the taper is pushed into the adapter. The fluid content of the test vessel is then placed under atmospheric pressure with the burette always open at its top.

With inlet and discharge needle valves "I" and "J" open, a slight pressure by dead weight tester is exerted on the oil, which is forced against the mercury "U" tube, and the same pressure is transmitted by displacement of this mercury piston to the fluid in the test vessel. The test fluid rises into graduated section of the micro-burette for a first reading at atmospheric pressure.



Footnote that speaks volumes

Here's one time when an asterisk refers to a really *important* footnote.

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Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 22" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5 9/16" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	24" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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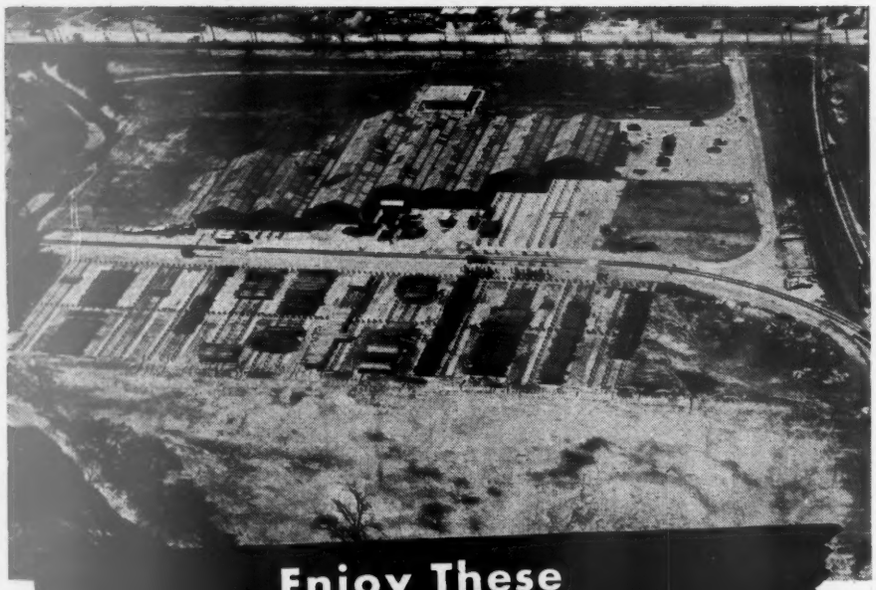

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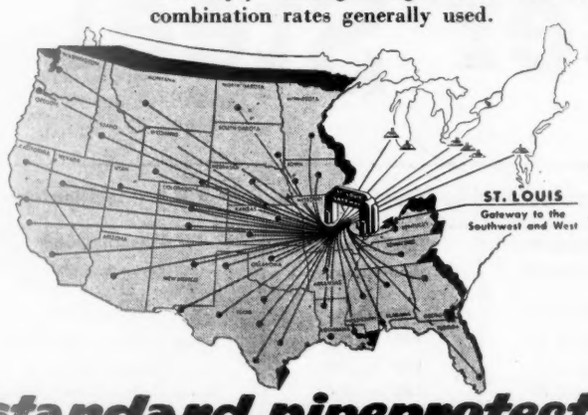

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Upon closure of the discharge valve a small quantity of fluid is displaced upward, which increases the first reading of fluid in the burette to the exact initial value used in the test data. Opening of the valve causes a lowering of fluid in the burette equal to the quantity displaced by movement of the valve needle. The required number of weights are placed on the pan of the tester. Pressure is then applied through the tester until the pan connected to the piston of the tester is elevated about ¾ in. above the surrounding cylinder. Weights, pan, and piston are spun continuously during application of pressure to the system. The Bourdon gage is used only as an indication of the unit pressure, to keep the operator from raising the tester piston too high and forcing it out of the cylinder.

As the desired unit pressure is reached, the inlet valve is closed uniformly at a very slow rate. Unit pressure is thus locked within the test vessel. The discharge valve "J" is opened slowly and the quantity of fluid compressed from atmospheric pressure to the applied higher test pressure is permitted to expand into the burette at atmospheric pressure to an approximate final reading. The discharge valve is then closed slowly to eliminate all error due to the volume displaced by the valve needle. The ultimate rise of fluid in the burette, as read with a magnifying glass, is taken as the true final reading. The difference between the true initial and final readings is the change in volume ($\triangle V$) of equation 2 caused by re-expansion of the fluid from the test pressure to atmospheric pressure.

Providing there is sufficient volume of fluid above the mercury leg of the piston, the final reading of the burette can become the initial reading for a second test. The burette need not be removed for cleaning until such time as the total calibrated length has been wet by the fluid. A strong Alkonox and distilled water cleaning solution is used at about 200 F to wash test fluids from the inside of the burettes. Burettes are flushed with distilled water and dried by compressed air prior to re-greasing the outside of the taper and continued use. Before the mercury in the "U" tube is driven past the invert, the bleeder valve "K", Fig. 4, is opened to atmospheric pressure. Test fluid is poured into the pipe system, and the necessary quantity of oil is removed from the dead weight tester. Time is then allowed for the fluid in the test vessel to again arrive at the desired test temperature before further runs are made. * * *

Part 2, the conclusion, will be published in an early issue.

Here are 15 TYPICAL APPLICATIONS for FIN-FAN AIR-COOLED Heat Exchanger Equipment

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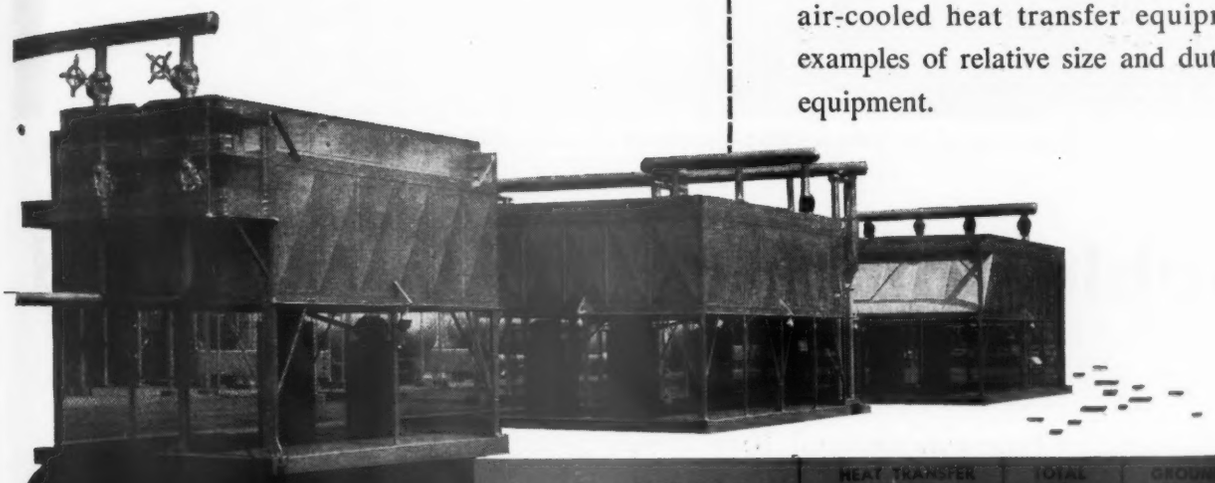

	SERVICE	HEAT TRANSFER (BTU/HR.)	TOTAL H.P.	GROUND SPACE
GAS COOLING	Natural Gas After-Cooler	13,920,000	80	46′ x 25′
	Manufactured Gas Cooler	11,165,000	50	23′ x 21′
	Natural Gas After-Cooler	3,400,000	15	11′ x 21′
	Natural Gas Inter-Cooler	7,890,000	40	23′ x 21′
VAPOR CONDENSING	Reflux Condenser	18,407,000	90	48′ x 25′
	Primary Condenser	4,652,000	40	11′ x 25′
	Still O.H. Condenser	4,875,000	34	16′ x 21′
	Debutanizer Condenser	11,930,000	60	23′ x 25′
	Still Reflux Condenser	39,110,000	60	46′ x 25′
	Steam Condenser	87,300,000	300	138′ x 31′
	Steam Condenser	2,880,000	10	10′ x 6′
LIQUID COOLING	Vegetable Oil Cooler	628,000	15	6′ x 17′
	Absorption Oil Cooler	14,915,000	100	32′ x 17′
	Quenching Oil Cooler	1,665,000	50	23′ x 25′
	Amine Solution Cooler	19,300,000	175	38′ x 25′
	Stabilized Crude Cooler	125,100,000	700	315′ x 25′
	Jacket Water	2,400,000	5.5	16′ x 12′
	Jacket Water	28,800,000	100	70′ x 24′

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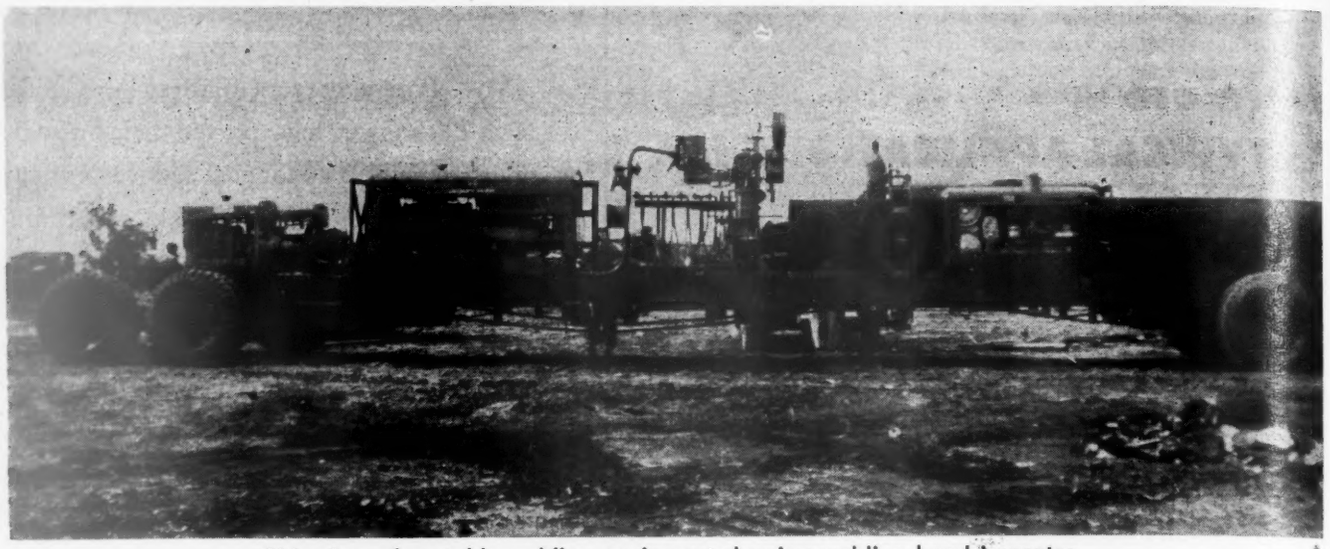


Side view of portable welding equipment showing welding head in center.

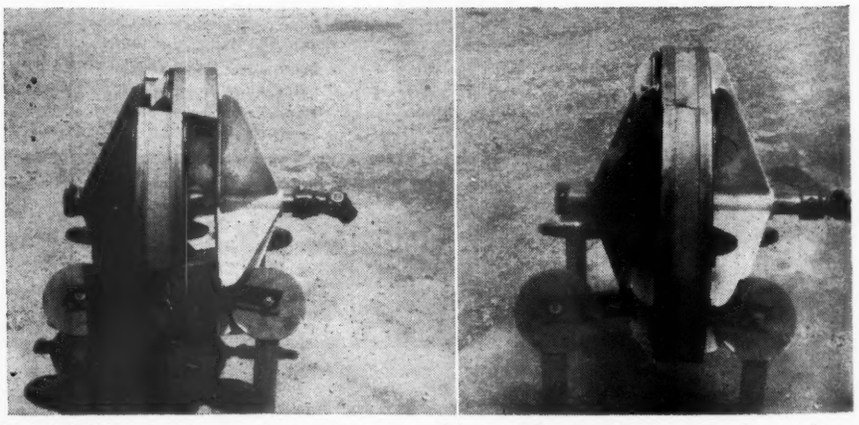
Double-Jointing Pipe in the Field

Portable equipment being used in Virginia on the Transcontinental line keeps pace with the job, operating immediately behind ditching machine

FRANK H. LOVE

PORTABLE welding equipment of new design has recently been shipped to Virginia and is being used to double-joint 30-in. pipe on the Transcontinental Gas Pipe Line Corporation system, which is being laid from Texas to New York City. The principal feature of the equipment is that the double-jointing is done in the field, at the point on the line where it is required, eliminating the additional handling involved when the pipe is double-jointed in a central yard and transported to the line activity perhaps miles away. The new machine keeps pace with the progress of the job by following along behind the ditching machine. Another feature is a special line-up clamp that makes the running of a stringer bead unnecessary. The equipment and process described in this article were developed by the O. R. Smith Manufacturing Company of Fort Worth, Texas.

The welding head itself is a Lincoln automatic submerged arc-welding type. The main frame upon which this and the auxiliary equipment are mounted is 28 ft long and 8 ft wide; however, an extension in the rear for additional support rollers, and a goose-neck arrangement in front for towing purposes, give the unit an overall length of 40 ft. There are two axles in front and rear on which are assembled tandem pneumatic wheels for traveling on roads or hard ground. To permit traction through mud, the front wheels can be replaced with Athey tracks. Provision also is made for fitting a third axle midway between the center and rear, and when this is used the rear axle may be removed. Locking plates and pins are removed from the rear extention so that it is free to lift should it touch the ground when the machine is traveling over rough or sloping terrain.



Special line-up clamp that makes possible welding without use of a stringer bead. Left, wedge surfaces of clamp disengaged. Right, surfaces fully engaged.

The operating platform is 3 ft above the ground. In the center is the automatic submerged arc-welding head.

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Air compressor and welding head are shown mounted on frame with one joint of pipe in place.

Two 400-amp welding machines are positioned on opposite sides and an air compressor of 210 cu ft capacity is situated on one side toward the rear of the unit. This arrangement gives balance and equal weight distribution on the frame, as well as providing working convenience. One side at the front is open and free of equipment, so that the pipe may be brought into the machine and set on to the endo dollies or placed in storage racks on the side. The endo dollies can be raised or lowered by air cylinders and are driven both forward and in reverse by air motors.

The pipe is fed into the welding machine by sideboom tractors and, after double-jointing, is supported by other tractors fitted with calipers while additional joints are welded onto the string of pipe. The first length of pipe is moved into the correct position for welding before the second joint is placed in the machine. Once the pipe is in position, overhead holding down arms seat themselves on top of the pipe to balance overhang. The arms are fitted with spherical ball rollers that allow the pipe to rotate or move in and out of the machine with the arms in position. The cylinders that actuate these arms may be regulated to increase or decrease the hold-down force exerted on the pipe.

Once the two lengths of pipe are in the correct position for welding, the endo dollies are lowered and the pipe seats on radial support rollers that have rubber tires. The welding head is fully floating to insure smooth and even rotation and the rubber rollers allow the longitudinal weld in the pipe to pass over them without causing any movement at the electrode where sudden shock is undesirable when welding with high amperage.

Other special features of the equipment are the arrangements for recovery of the welding slag, self-lubrication of air-operated equipment, and the arrangement of the air system, which provides an adequate supply of air at all times by the use of auxiliary air tanks and a system of check valves.

An integral part of the portable equipment is a special design of line-up clamp. This clamp enables double-jointing to be done without the conventional stringer bead, as mentioned. The clamp consists of six equal segments that abut each other at 60 deg and are tapered across the face of the clamp to give a wedge-like action when the clamp is expanded to the required diameter. Each segment is water-cooled and supported by two arms that radiate from two center hubs. A lead screw passes through both hubs, which are threaded left hand and right hand. When the lead screw is turned, all segments move toward each other. The angle of the wedges causes each shoe to move outward, increasing the outer diameter, and the correct inside pipe dimension is attained when the wedge surfaces are fully engaged.

The clamp incorporates an unusual self-aligning feature that keeps it centrally positioned within the pipe at all times. This makes it easy to fit the ends of the two joints together before the clamp is finally expanded. The clamp is operated by an extension rod and an electric wrench, and the carriage upon which it is mounted has four wheels fitted with roller bearings and a spring loaded tension wheel.

It has been learned that by proper control of the variables, such as voltage, amperage, and welding speed during double-jointing by the submerged arc process the clamp may be used without the stringer bead. With a

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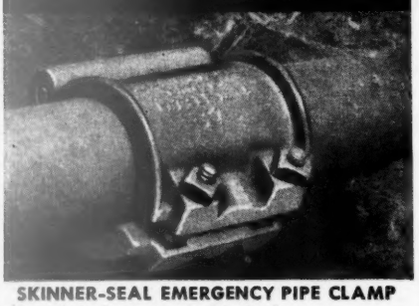

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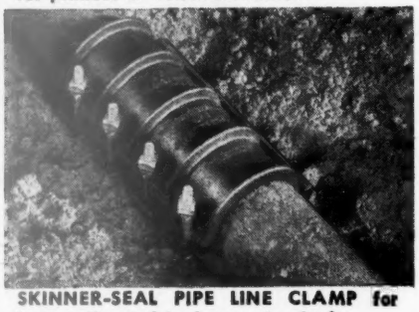

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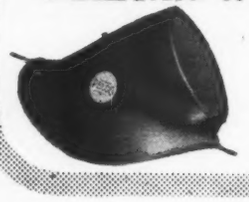

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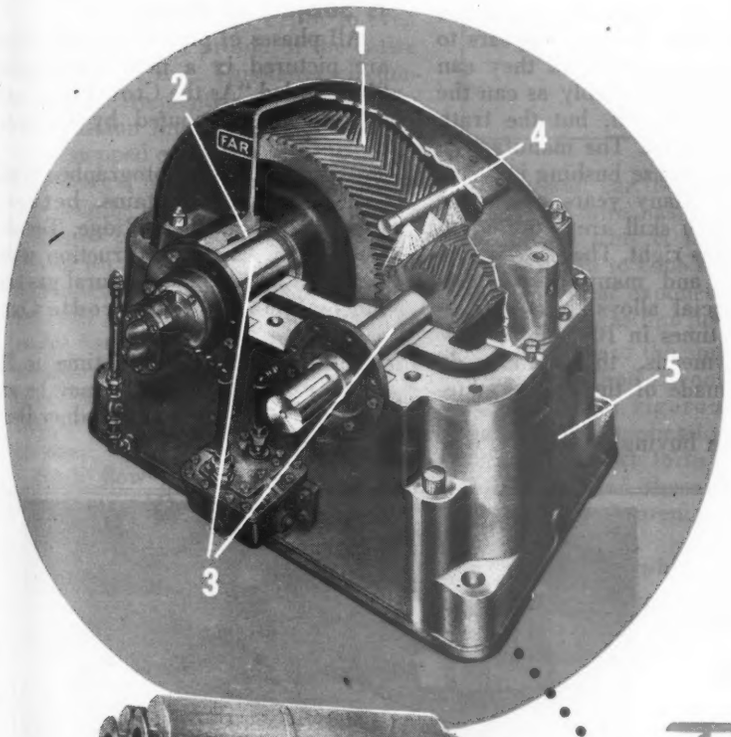

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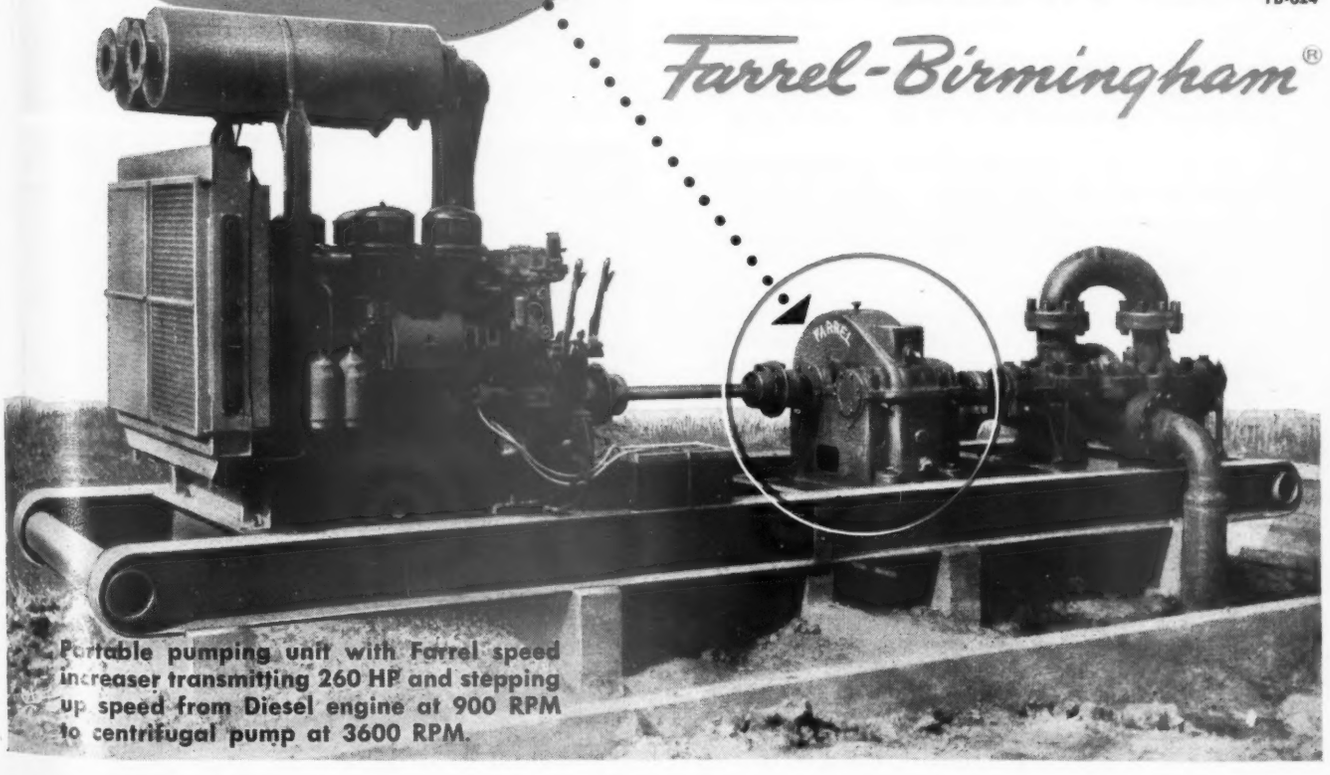

Portable pumping unit with Farrel speed increaser transmitting 260 HP and stepping up speed from Diesel engine at 900 RPM to centrifugal pump at 3600 RPM.

manually applied stringer bead there is always the possibility of icicles forming inside the pipe, undercutting, and the formation of slag pockets, which are sometimes impossible to detect except by X-ray examination. Less obvious is the degree of oxidation of the metal, which can be revealed only by physical tests or metallurgical examination. When the submerged arc process is used throughout the welding operation, it follows that a more uniform weld of consistently high quality is produced. One explanation for this is that, as the second pass follows immediately upon the first, the metal does not have a chance to chill, and the high amperage produces sufficient heat to completely normalize the first weld. To test this, coupons have been cut from pipe welded in two passes and using the line-up clamp, and bent 180 deg without indication of cracking or fracture. Examination of the structure showed perfect fusion and a refined pearlitic structure in which the optimum physical properties were developed. There were no blow holes, non-metallic inclusions, or other types of imperfections. The line-up clamp also has been found satisfactory when dealing with differences in pipe diameter, or what is known as a high-low condition.

* * *

Do You Know These Facts About Repair Parts of Machines?

Instead of trying to make your own repair parts, it is usually more economical and better in every way to buy them from the manufacturer of the machine needing repairing. In special emergencies it may be excusable to hire a neighboring mechanic to make a repair part for you, but, the chances are that the part won't fit as well as would a part purchased from the maker of the machine. As a result the machine will give less efficient service, its usefulness will be impaired, and the reputation of the manufacturer may be injured for no fault of his own.

Consider, for example, a part as simple as a brass bushing appears to be. Many mechanics think they can make bushings as capably as can the manufacturer himself, but the truth is that they cannot. The manufacture of a finished bronze bushing is a specialized job. Many years of experience and much skill are required to make bushings right. The same is true of bearings and many other parts made of special alloys. It is safe to say that 99 times in 100, in this day of special metals, the home-made product is made of the wrong material.

Also, when buying machinery, it is usually best to buy standard machinery rather than something "special." If the machine is standard the manufacturer can supply you with repair parts at less expense and more quickly than if the machine is special. For standard machines the manufacturer generally has an ample supply of repair parts in stock. For special machines, if repair parts are needed, the manufacturer must refer back to his blueprints and make those parts as they are seldom kept in stock.

W. F. S.

Pipe Line Construction Is Subject of Movie

All phases of pipe line construction are pictured in a new construction film entitled "As the Crow Flies," and now being distributed by Gardner-Denver Company.

All scenes were photographed in the Cumberland Mountains, between Green Brier and Oak Ridge, Tennessee. Action shows construction work on the 172-mile, 22-in. natural gas line laid by Oman-Fulton-Brodie Company.

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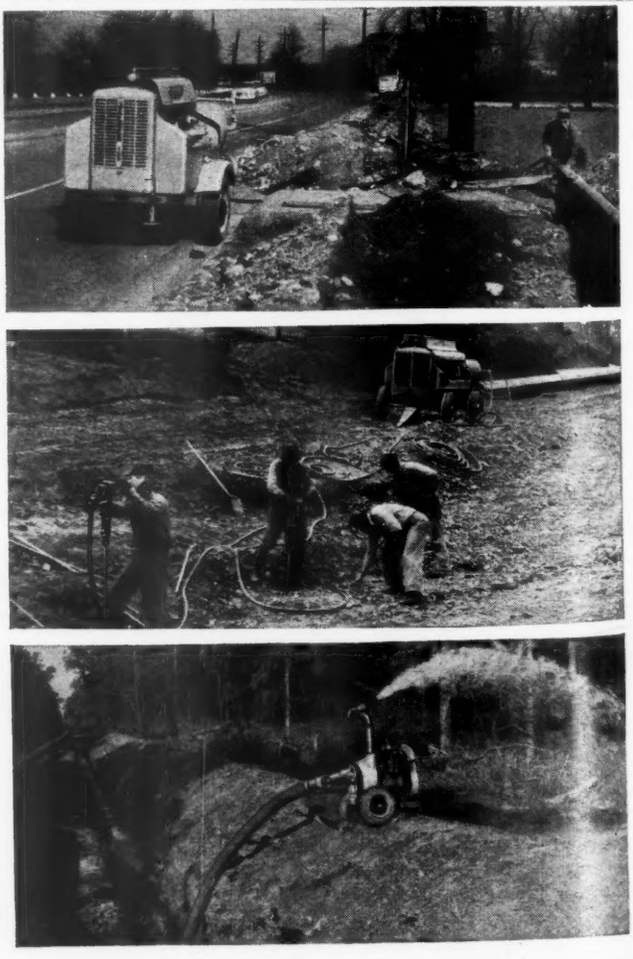


A Graphic Method for Solving

Gas Pipe Line Pressure Problems

W. L. DUCKER

In the design of gas transmission lines, as well as gathering systems, it is frequently desirable to know the pressure P_o at some intermediate point along a line for given conditions of inlet and outlet, P_1 and P_2 (Fig. 1), or to even plot the pressure profile of the entire length of the line. This latter circumstance is frequently encountered in transmission line design when studying a stepped or graduated wall thickness design, or in the selection of station lengths or intervals.

These problems may be readily solved for lines of either uniform or non-uniform diameter by the use of any one of the several accepted formulas for flow of gas through transmission lines, and the results in most cases would be independent of the particular flow formula that might be chosen.

Such flow formulas are involved, however, and the calculation of a pressure profile becomes a tedious chore. Much of the work can be alleviated by the use of an appropriate "gas pipe line slide rule", but even then the results may not be of high accuracy. The method proposed here will be found to yield highly accurate results more quickly on profiles requiring many pressure determinations along a line, and can be employed by the field man who has no special equipment and who is too rusty on his mathematics to cope successfully with the fractional exponents that characterize these gas line flow formulas.

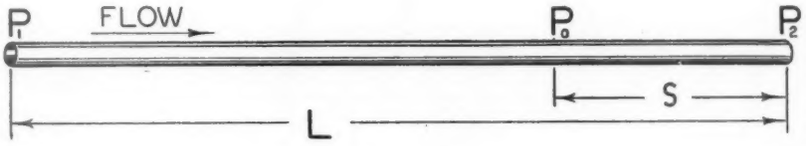


FIG. 1.

As the use or the application of this graphic method is considerably more simple than a rigorous proof of its validity, its application to the problem will be set forth first, and then following, for those interested, the proof of the theorem will be presented.

The Graphic Method

The graphic method of determining the pressure at any point along a gas transmission line is applicable *only to non-branching lines of constant diameter.* It is based on the relationship between the terminal pressures and the length of the line as expressed in the factor $\left[\frac{P_1^2 - P_2^2}{L}\right]$ which is contained in most of the accepted gas pipe line flow formulas.[1]

The following geometric construction will illustrate the application of this method to the solution of such problems. (See Fig. 2).

(1) To a horizontal line erect a perpendicular at C.

(2) From C, lay off to the left, to any convenient scale, the line outlet or discharge pressure $P_2 = \overline{CA}$.

(3) From point A, and to the same scale, lay off the line inlet pressure P_1 so that it intersects the vertical line through C at $P_1 = \overline{AD}$ (P_1 and P_2 in lb/in² abs.)

(4) With C as a center and $\overline{CD}$ as a radius describe the arc DB.

(5) From E, the midpoint of $\overline{CB}$, drop a perpendicular line.

N.B. The line segment $\overline{CE}$ now represents the total length of the pipe line, with flow from left to right as indicated. Assume that the line in question is 10,000 ft long and that pressure data are required at a point 6800 ft from the input end.

(6) Through C as shown lay a scale of any convenient graduation so that the total scale length of the pipe line (10,000 ft) intersects the vertical line through E.

With the scale thus in place locate the scale point where pressure data are required. (In this case it is 6800 ft as shown in Fig. 2.) From this point draw a vertical line to intersect $\overline{CE}$ at O.

(7) With O as a center and with $\overline{OB}$ as a radius, describe the arc BD′.

(8) Draw the line $AD' = P_o$; P_o being the absolute line pressure at the required point, to the same scale as was used in plotting P_1 and P_2.

It may be noted that as point O is moved toward point C (the input end of the pipe line) point D′ approaches point D, and pressure P_o approaches pressure P_1, the line input pressure; and as point O is moved toward point E (the discharge end of the pipe line) point D′ approaches point C, and pressure P_o approaches pressure P_2, the line terminal pressure.

Proof of the Theorem

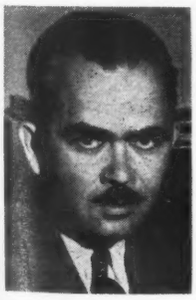
Most of the various flow formulas that have been proposed for use in the calculation of pipe line flow of natural

[1]For example, Weymouth's Formula:

$$Q = 18.062\, d^{8/3} \frac{T_o}{P_o}\left[\frac{P_1^2 - P_2^2}{GTL}\right]^{1/2}$$

where the terms are as defined under equation (1) of this article.

The Author



W. L. Ducker is head of the department of petroleum engineering at Texas Technological College, Lubbock, Texas. A graduate of Oklahoma University, Ducker joined Barnsdall Oil Company in the engineering department immediately after graduation. He was subsequently employed by Consolidated Gas Utilities Corporation, and later was chief engineer for Seismograph Service Corporation and Engineering Laboratories, Inc., and the Bovaird Supply Company. From 1941 to 1947 he was engaged in consulting engineering practice in Tulsa, Oklahoma, joining the Tech faculty in 1948.

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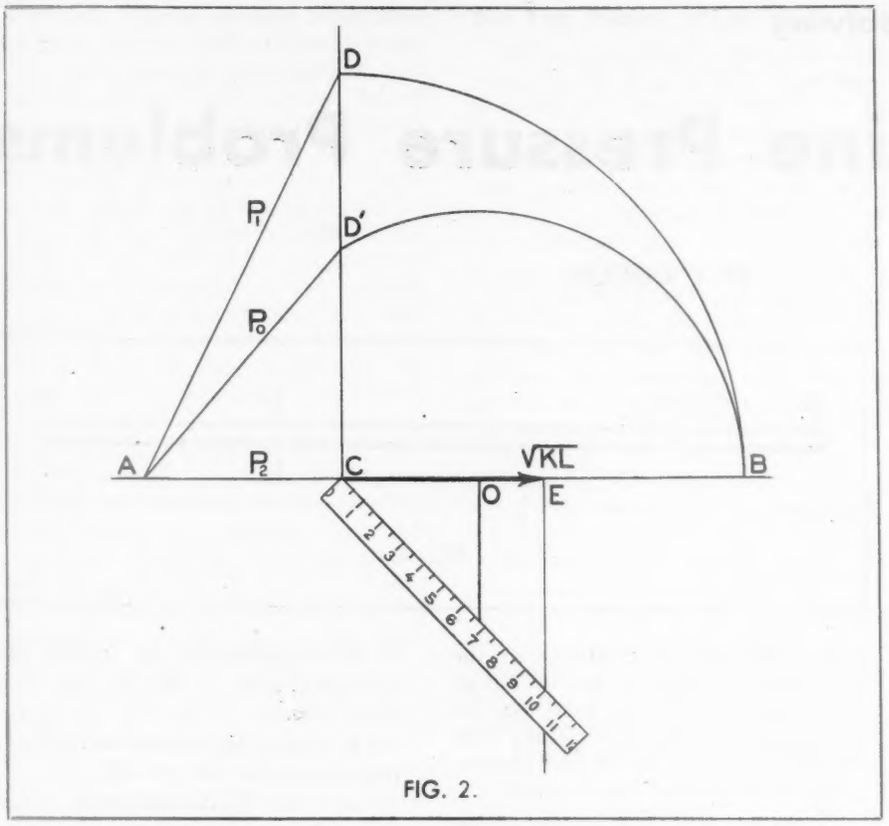

FIG. 2.

gas may be reduced to the general form[2],

$$Q = 1.6156\, fd^{5/2} \frac{T_o}{P_o}\left[\frac{P_1^2 - P_2^2}{GTL}\right]^{1/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which is derived, with certain qualifying assumptions, from the general energy equation for any thermodynamic flow process, and wherein:

- Q = Volume of gas in cu ft per hr at base T_o and P_o
- T_o = Temperature base, °F abs.
- P_o = Pressure base, psia
- P_1 = Input pressure, psia
- P_2 = Outlet pressure, psia
- d = Internal diameter of the pipe, in.
- G = Specific gravity of gas (Air = 1.000)
- T = Temperature of flowing gas, °F abs.
- L = Length of line, miles
- f = Coefficient of friction. No units.

When such formulas are reduced to the general form, (equation 1), they will be found to differ primarily only in the nature or form of the friction factor f; whereas the pressure—length term $\frac{P_1^2 - P_2^2}{L}$ will be found to occur undisturbed in all such formulas.

Thus an examination of the general form of the flow equation (equation 1) or any of the special formulas will show that for any given line, operating under conditions of constant (steady state) flow, each of the terms of the equation will be constant, including the pressure—length term.

Thus:

$$\frac{P_1^2 - P_2^2}{L} = K \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We can with equal validity, however, generalize the above expression so that it will describe the pressure-length relationship of *any portion or section of the given line*, if we let p_1 equal the pressure at the high pressure end of the section, p_2 be the pressure at the low pressure end of the section, and s be the length of the section.

Then:

$$\frac{p_1^2 - p_2^2}{s} = K \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where p_1, p_2, and s are in the same units as the corresponding terms in equation (2) and where K is numerically equal[3] to K in equation (2).

It may now be noted that if p_1 is taken at the input end of the line, and p_2 is taken at the discharge end of the line, equation (3) becomes identical with equation (2).

In the problem of determining the pressure P_o (Fig. 1) at some intermediate point along a gas pipe line, it is convenient to consider the application of equation (3) to that portion of the line lying between the point of unknown pressure P_o, and the discharge end of the line at pressure P_2.

In this case p_1 in equation (3) becomes equal to P_o, and p_2 becomes equal to P_2,

$$\text{or} \quad \frac{P_o^2 - P_2^2}{s} = K \quad . \quad . \quad . \quad (4)$$

$$\text{or} \quad P_o^2 - P_2^2 = Ks \quad . \quad . \quad . \quad (5)$$

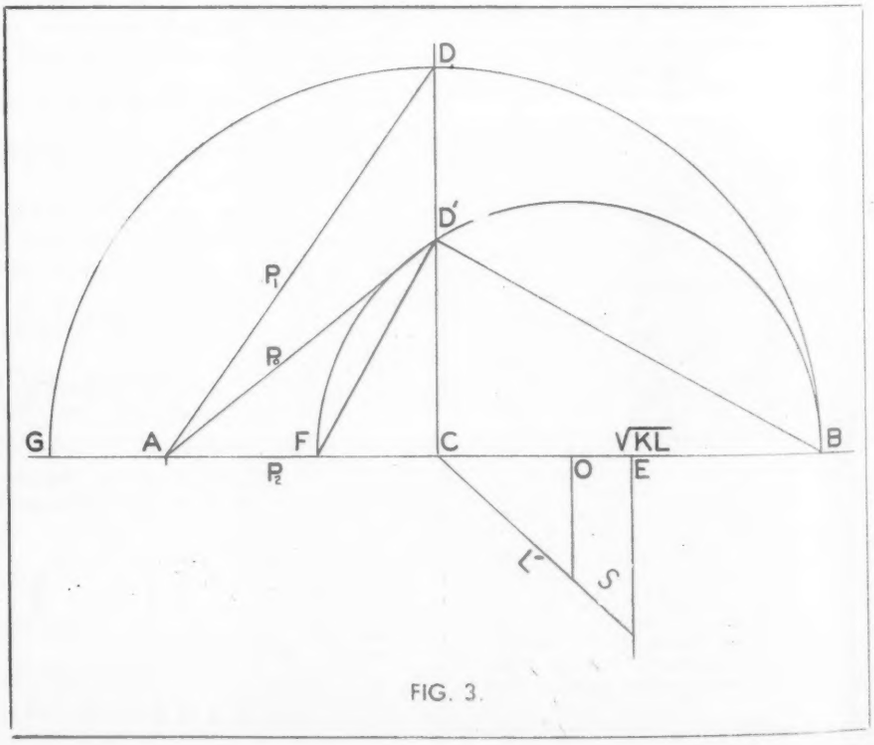

FIG. 3.

[2] "Flow of Natural Gas Through High Pressure Transmission Lines," T. W. Johnston and W. B. Berwald, U. S. Department of Interior, Bureau of Mines Monograph No. 6, February, 1935, Appendix No. 1, pp. 86-92.

[3] As the value of the constant K depends upon the factors of the flow formula other than pressures and lengths, and if equation (3) is restricted to use only on sections of a given line to which equation (2) is applicable, then K of equation (2) is equal to K of equation (3). Until a numerical value is assigned to K, L and s may be in any units that may be convenient so long as consistency is maintained.

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Dope men working on lines all over the country have finally gotten what they wanted—a pipe wrap that is virtually unbreakable under normal working conditions. It's the new Parallel Reinforced Coromat made of Fiberglas by the Owens-Corning Fiberglas Corporation. This new wrap is the end result of years of experimentation and study by the Owens-Corning people, pioneers in the glass wrap field. Coromat, distributed by Midwestern, is a porous mat of glass fibers reinforced with strands of Fiberglas yarn which run parallel to the length of the wrap. These yarns are scientifically spaced ⅜" apart and afford the utmost strength where the application strain is greatest. The greatly increased tensile strength of this wrap permits the use of the longer 1200-foot rolls at high wrapping speeds without the danger of breakage. Naturally, being glass, Coromat resists acids and electrolysis. It has no wicking action, it has the highest impact resistance and won't sag. The new Parallel Reinforced Coromat is available from Midwestern in 75, 400, 800, 1000, and 1200-foot rolls.

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and for the total line of length L,

$$P_1^2 - P_2^2 = KL \quad . \quad . \quad . \quad (6)$$

To the construction and notations of Fig. 2 add the following constructions and the notations shown in Fig. 3.

(1) Extend arc BD to G
(2) Extend arc BD′ to F
(3) Add lines $\overline{FD'}$ and $\overline{BD'}$
(4) Add notations $\sqrt{KL}$, L′, s′, as shown.

Then if equation (6) is rewritten thus:

$$P_1^2 - P_2^2 = \sqrt{KL}^2 \quad . \quad . \quad . \quad . \quad (7)$$

it has the form of a right triangle of sides P_2 and $\sqrt{KL}$, and with a hypotenuse of P_1. This right triangle is incorporated in Fig. 3 as triangle ACD and in which its altitude, and therefore also the radius of the arc GBD is equal to $\sqrt{KL}$.

In a like manner if equation (5) is rewritten thus:

$$P_0^2 - P_2^2 = \sqrt{Ks}^2 \quad . \quad . \quad . \quad . \quad (8)$$

it may also be plotted as a right triangle ACD′, Fig. 3, having the side AC common with triangle ACD, and having its altitude CD′ equal to $\sqrt{Ks}$

To Be Proved:

If the construction given for Fig. 2 gives for the line segment $\overline{CD'}$ a value of $\sqrt{Ks}$, then triangle ACD′ and equations (5) and (6), will be satisfied and the method will be valid.

By construction 6, of Fig. 2:

$$s'/L' = S/L \quad . \quad . \quad . \quad . \quad . \quad (9)$$

By similar triangles:

$$\overline{OE}/\overline{CE} = s'/L' = s/L \quad . \quad (10)$$

For any two circles, the difference of the diameters is to the difference of the radii as two is to one.

Therefore:

$$\overline{GF}/\overline{CO} = 2/1$$

or $$\overline{GF} = 2\,\overline{CO} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

By construction 5, of Fig. 2:

$$\overline{GC} = 2\,\overline{CE} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Subtracting (11) from (12):

$$\overline{FC} = 2\,\overline{OE} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

From (12) and (13):

$$\overline{FC}/\overline{GC} = \overline{OE}/\overline{CE} \quad . \quad . \quad . \quad (14)$$

But from (10) $\overline{OE}/\overline{CE} = s/L$, therefore:

$$\overline{FC}/\overline{GC} = s/L \quad . \quad . \quad . \quad . \quad (15)$$

As $\overline{FB}$ is the diameter, and D′ is on the circumference of a circle, Angle FD′B is a right angle, and triangles FCD′, FD′B and D′CB are all mutually similar.

Therefore:

$$\overline{FC}/\overline{CD'} = \overline{CD'}/\overline{CB}$$

or $$\overline{FC} \times \overline{CB} = \overline{CD'}^2 \quad . \quad . \quad . \quad (16)$$

From (15), and since $\overline{GC} = \overline{CD}$

$$\overline{FC} = \frac{s\overline{CD}}{L} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Substituting (17) in (16), and since $\overline{CD} = \overline{CB}$

$$\frac{s\overline{CD}^2}{L} = \overline{CD'}^2$$

or $$s/L = \overline{CD'}^2/\overline{CD}^2 \quad . \quad . \quad . \quad . \quad (18)$$

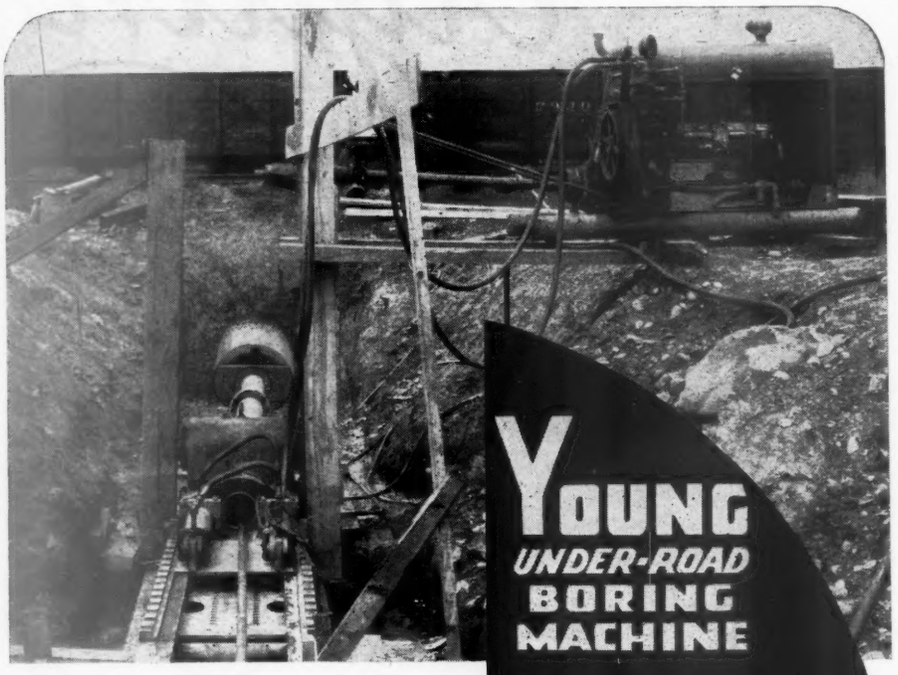
multiplying and dividing the first term of (18) by K, and taking the square root of both terms

$$\frac{\sqrt{Ks}}{\sqrt{KL}} = \frac{\overline{CD'}}{\overline{CD}} \quad . \quad . \quad . \quad . \quad (19)$$

As $\overline{CD}$ does equal $\sqrt{KL}$ by construction of triangle ACD, then $\overline{CD} = \sqrt{Ks}$.

Q. E. D.

* * *



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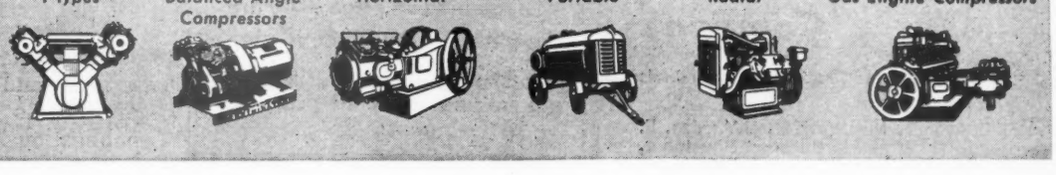

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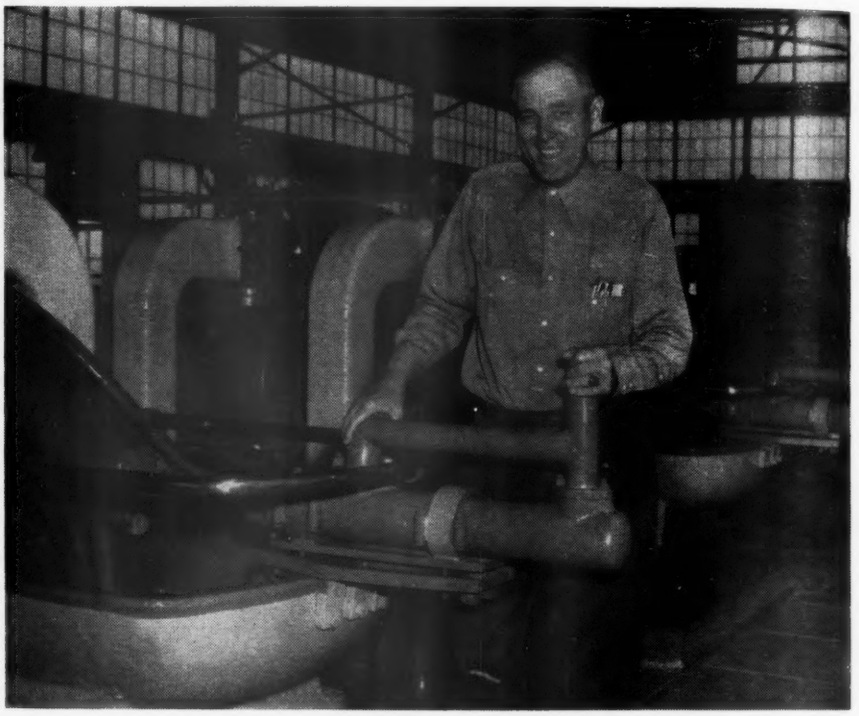
Piston Water Receiver Improves Water-Cooling Efficiency

JOHNNY CRUTCHER, chief operator at Station No. 3 on the El Paso Natural Gas Company system, has designed a mechanism that increases substantially the effectiveness of water cooling in the Cooper-Bessemer Type 19 engines and, as a result, lengthens the life and improves the performance of these engines.



Johnny Crutcher and the piston water receiver he invented.

Known as a piston water receiver, the device takes water from the reciprocating piston rod of the engine and delivers this water to piping leading to cooling apparatus. Without the piston water receiver, cooling water from the engine falls through the open air from the engine to a collecting trough, which carries it to the appropriate piping.

The piston water receiver offers several advantages over the older method of circulating water. For one thing, the receiver prevents oil from getting into the cooling water and eliminates the building of an oil film in the engine water jackets, the water piping, the cooling towers, and other apparatus. This oil film decreases the efficiency of the cooling system and the elimination of it is resulting in more effective cooling.

Without the piston water receiver, water moves through the piston and its rod in a "sloshing" action. This sloshing action creates a bad erosive condition and accelerates corrosion. With the receiver in place, water moves smoothly and in one direction through the rod. The erosive action is eliminated; the corrosive tendency is much reduced.

Flow of water is controlled by means of the receiver. The piston and its rod are maintained at the same temperature, therefore, as the cylinder walls of the engine. This makes possible better lubrication of the engines and decreases wear of the parts concerned.

The water receivers have been installed in Stations No. 2 and 3.

Story and picture are by courtesy of El Paso Natural Gas Company's publication *The Pipeliner*. * * *

New Pipeline Projects

Beginning on page D-40 are the plans for the future in pipe line building. The new war footing has not affected projects.

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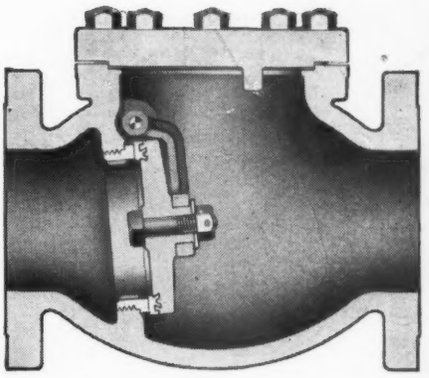

No. 39E, Flanged Swing Check Working Pressures: 250 pounds steam, 450° F; 500 pounds water, oil, or gas. Sizes: 2 to 12-inch.

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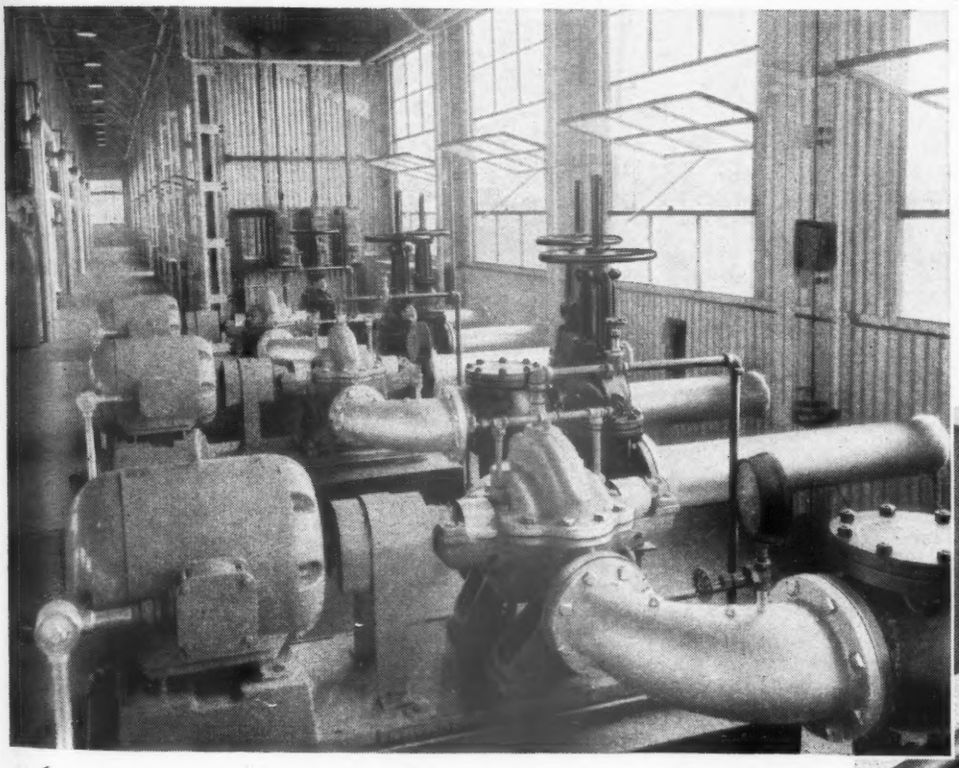

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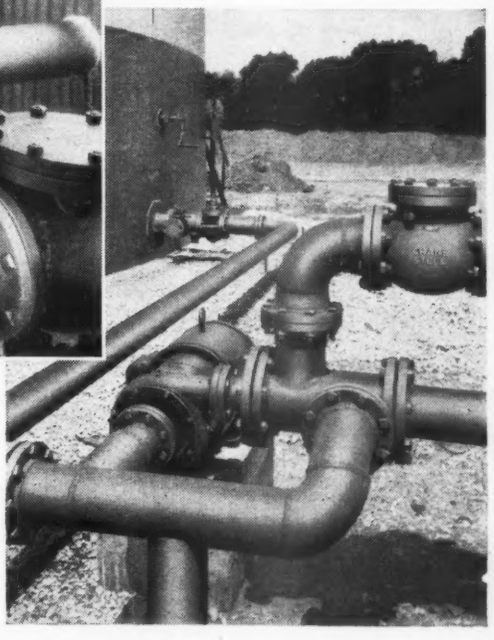

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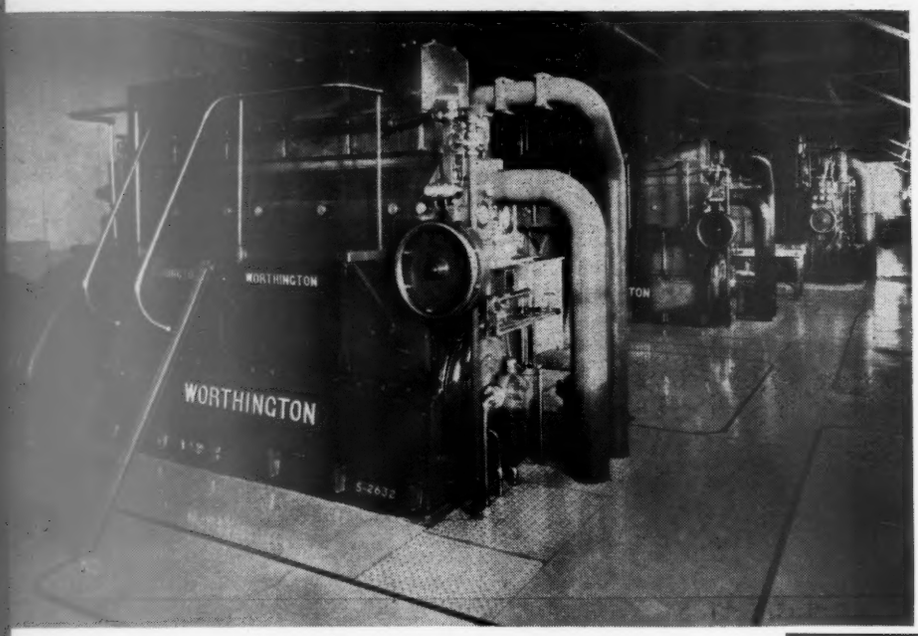
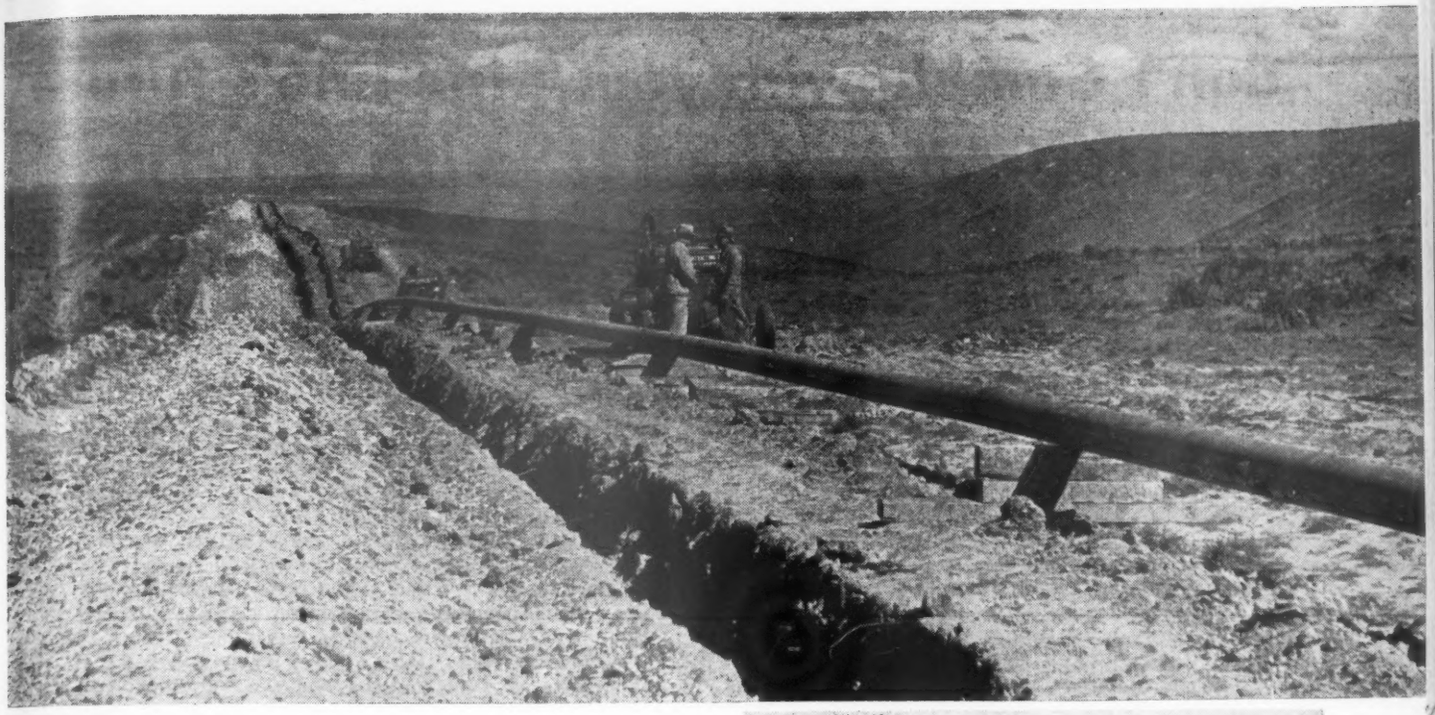


Engine room side of the Utah Oil Refining Company Pipe Line Department pump station at Wamsutter, Wyoming. The first two engines in foreground are Worthington CCX-5, 280-hp units. The third engine is a Worthington SDD-6, turbocharged 820-hp unit. No. 4 and No. 5 engines, not visable in picture, are Worthington DDX-6, 520-hp. units. All units are direct connected to crude oil pumps, plungered for operation at 1500 psi.

Virgil M. Bull below, superintendent of Omaha Dredge and Dock Company, and R. C. Hooks, chief inspector for Fish Constructors, Inc., at river crossing location near New Roads, Louisiana. The Mississippi River is being crossed with dual lines at this point for Transcontinental Gas Pipe Line Corporation.

It was men and machines against mountains and mud as Morrison Construction Company put the last of a 40-mile stretch of 30-in. pipe in the ditch near Cross Plains, Tennessee, for Tennessee Gas Transmission Company. In the foreground is an all-new "king-size" boom tractor, an International TD-24 equipped with the latest model Superior pipeboom.



Welded pipe strung along a right-of-way near Boise, Idaho, as workers near completion of a 566-mile oil products pipe line being built from Salt Lake City to Pasco, Washington, by Salt Lake Pipe Line Company, a subsidiary of Standard Oil Company of California.

H. L. Leake, spread superintendent for Latex Construction Company on Mid-Valley line. L. C. Bains, ditch foreman. Taken near Benton, Louisiana.

Put another wrinkle in! This bending crew is adding another bend in the Tennessee Gas Transmission Company line to Buffalo, being laid by H. C. Price Company of Bartlesville, Oklahoma.

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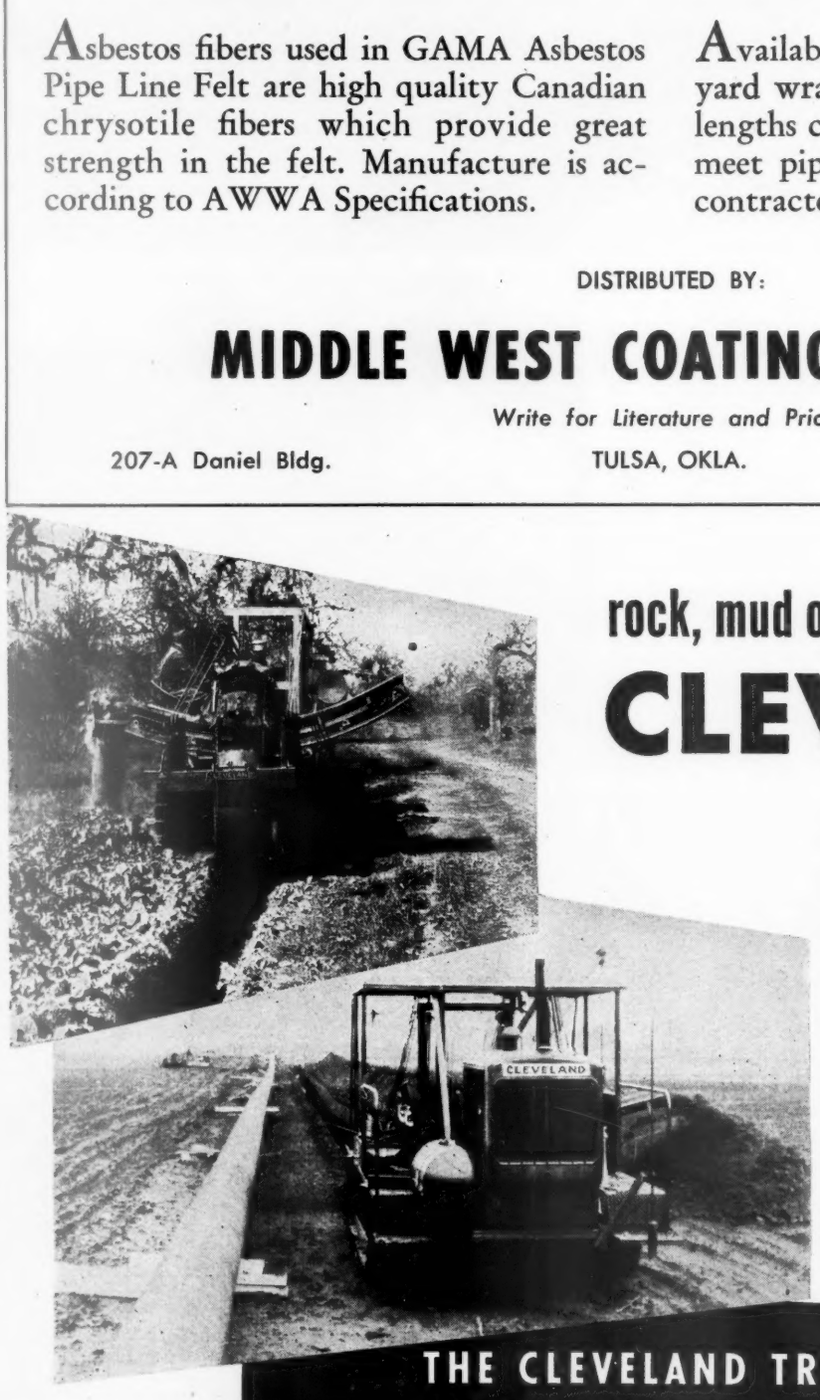

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NEWS

Michigan-Ohio Pipeline Corporation Is Formed

Mid-West Refineries, Inc., has announced the formation of Michigan-Ohio Pipeline Corporation, with offices in Grand Rapids, Michigan.

L. A. Woodward, president of Mid-West Refineries, Inc., is president of the new pipe line company and C. A. Schrader, vice president and general manager.

Michigan-Ohio Pipeline has entered into a contract to acquire the 250 miles of crude oil trunk line of the Michigan division of Sohio Pipe Line Company.

These lines extend from Toledo, Ohio, to Freeman and Buckeye, Michigan, oil field area of central Michigan.

Schrader stated that there would be no changes in the present operating personnel of the pipe lines and that the operating office would continue to be in Mt. Pleasant, Michigan.

He also said that Michigan-Ohio Pipeline will continue to serve Michigan refineries as in the past.

Holland Construction Back in Business

H. T. "Bus" Holland, founder of the Holland Construction Company, has announced the company's return to active business in the field of pipe line construction. The company, which is opening new offices at 906 First National Building in Tulsa, Oklahoma, is actually already at work on its first contract, constructing 20 miles of 22-in. line for the Washington Gas Light Company. Holland is also president of the Oklahoma Glass Fiber Corporation with plant at Newport, Arkansas.

FPC Suspends Proposed Gas Rate Changes

The Federal Power Commission has suspended proposed changes in Panhandle Eastern Pipe Line Company's rate schedules covering the sale and delivery of natural gas to Michigan Consolidated Gas Company (two rate schedules), Texas Gas Transmission Corporation, and The East Ohio Gas Company. No hearing date was set.

The changes involve Panhandle's proposal to cancel its present rate schedule for interruptible service to the three customer companies.

The commission said that the changes may be "unjust, unreasonable, unduly discriminatory, preferential and unlawful contrary to the provisions of the Natural Gas Act."

Michigan Consolidated Gas Company and the City of Detroit, Michigan, protested the cancellations and requested the suspension.

Contracts Awarded for Texas-Illinois Line

Major construction contracts have been awarded for the 1331-mile natural gas pipe line that Texas Illinois Natural Gas Pipeline Company of Chicago, is building from the lower Texas Gulf Coast area to the Chicago metropolitan region.

Joseph J. Hedrick, president of Texas Illinois Natural Gas Pipeline Company of America, announced that contracts have been completed with four major construction campanies.

These firms are the Midwestern Constructors, Inc., of Tulsa, Oklahoma; H. C. Price Company, of Bartlesville, Oklahoma; the Bechtel Corporation, of San Francisco, and the Fish Pipeline Construction Corporation, of Houston, Texas.

Midwestern Constructors, H. C. Price Company, and the Bechtel Corporation will build the pipe line, most of which will be of 30-in. diam steel pipe, while Fish Pipeline Construction Corporation build the system's compressor stations.

The entire construction project, Hedrick stated, is being directed by the management of Texas Illinois Natural Gas Pipeline Company, of which Mark V. Burlingame is vice president in charge of operations.

Federal Power Commission authorization for the transmission line, which will be built at an approximate cost of $120,000,000, was granted last June 14. Contracts for constructing the line and its several installations were completed shortly afterward, Hedrick said.

The new Texas Illinois line will be the third one supplying the Chicago region. Its output will augment the natural gas supply now being provided by Natural Gas Pipeline Company of America's dual lines to customer utilities in Illinois, Indiana, Iowa, Kansas, and Nebraska.

The FPC certificate required that construction begin by August 15 and directed that the pipe line be completed by the end of 1951. The certificate approved an initial daily capacity of 305,000,000 cu ft a day.

Midwestern Constructors will install that part of the transmission main that is to be laid in Illinois. This consists of 292 miles of 30-in. diam pipe extending from near Cape Girardeau, Missouri, through the central section of Illinois to the line's two terminal points, one of which is at Joliet, just southwest of Chicago, and the other at Volo, Illinois. In addition, the Tulsa firm will build a 100-mile section of 26-in. line in the Texas coastal plain.

H. C. Price Company has been awarded the contract to build 38 miles of 12-in., 36 miles of 24-in., 97 miles of 26-in., and 113 miles of 30-in. line, all of which will be laid in the coastal plain region. The Price company also will construct a 126-mile section of 30-in. main transmission line through the Piney Woods section of eastern Texas, north of Houston.

Bechtel Corporation's contract calls for constructing 420 miles of 30-in. main transmission line, which will span Arkansas and Missouri and will lie between the Ozark mountains and the lowlands of the Mississippi River. It includes the rolling terrain of the extreme southeast tip of Missouri.

The contracts awarded to the three firms call for laying 1021 miles of 30-in., 197 miles of 26-in., 36 miles of 24-in., and 38 miles of 12-in. pipe.

Four multiple-line submerged river crossings will be built. These will cross the Trinity River in Texas, the broad Arkansas River near Little Rock, Arkansas, the White River, in Arkansas; and the Illinois River, south of Joliet, Illinois. These crossings will be accomplished with double lines of heavy 24-in. diam steel pipe having a 1-in. wall thickness.

The Price Company will build the Trinity River crossing north of Houston. Bechtel will construct the Arkansas and White River crossings in Arkansas, and Midwestern Constructors will build the Illinois River crossing.

Four major rivers will be spanned by aerial crossings necessitating suspension bridges that have been designed by Mathews and Kenan of San Antonio, Texas. These are the Colorado and the Brazos Rivers crossings, in Texas, the Red River in Arkansas, and the big Mississippi crossing near Cape Girardeau.

Actual construction work on the compressor stations is scheduled to begin early this fall. Three compressor stations have been certified by the Federal Power Commission to be built at this time, and these installations will be constructed by Fish Pipeline Construction Corporation. Two additional compressor stations are contemplated by the Texas Illinois company to handle additional supplies of gas that have been contracted for.

Compressor station power units will be 2000-hp UTC engines, which will be supplied by the Worthington Pump and Machinery Corporation. Auxiliary units will be Cooper-Bessemer 600-hp engines, two to each station.

The entire 1021 miles of 30-in. pipe required for the line will be fabricated in the new Houston plant of the A. O. Smith Corporation of Texas, which has just been completed. The 20-in., 24-in., and 26-in. steel pipe needed for the project will be supplied from the Milwaukee plant of A. O. Smith.

NEWS

California Gas Line Ahead of Schedule

Construction of the 82-mile Texas pipe line loop of Southern California Gas Company is speeding smoothly along over the comparatively level terrain approaching the tie-in point west of Puente. If all goes as expected, gas will be moving through the new line sometime early in September, well ahead of the originally scheduled October 1.

Meanwhile, work is progressing on the 735-ft span suspension bridge crossing the Santa Ana River, and bids are being submitted for construction of the Puente Station.

The 30-in. line, which starts from a point on the present Texas Pipeline at the Whitewater River, northwest of Palm Springs, has now crossed the northern portions of Carbon and Brea Canyons and is heading into the cultivated country to the west, where the right-of-way parallels the Union Pacific Railway Line.

Route of the line from the starting point is by way of Banning, Beaumont, March Field, south of Riverside, across the Santa Ana River just east of Pedley, then across the Chino Valley south of Chino and over the Puente Hills to the connection point just west of Puente.

Pipe Line Contractor Sets Safety Record

In the midst of a greatly expanded pipe line construction program, H. C. Price Company of Bartlesville, Oklahoma, has announced that new low accident frequency records were set this year by its four main line spreads.

While no comparative figures are available on an industry-wide basis, it is generally acknowledged that pipelining is about the most hazardous of all construction work. For many years insurance companies set their rates on a basis of one death per each million dollars of construction. In addition to this high fatality figure, the frequency of injuries often ran in excess of 200 per million man-hours worked.

During the first half of 1950, Price construction crews employing approximately 1500 men established a low average of 21.7 for disabling injury frequency per million man-hours. This figure compares with a rate of 92.1 set for the same period in 1949 by these four spreads and a frequency of 133.1 for the first six months of 1948.

Because of a normally high rate of injuries among brush gangs and right-of-way crews, the opening phases of any pipe line project generally reflects a greater accident frequency than the finishing portion. This is indicated in the yearly average by Price crews during 1949, when the overall frequency per million man hours was reduced to 69.6 from the mid-year figure.

The H. C. Price Company's outstanding accident record can be attributed to a vigorous safety program launched in 1948. At that time, a safety supervisor was appointed and a campaign was undertaken to make all employees "safety conscious".

The company's safety program included the enactment of safety rules, the holding of safety meetings and first aid courses in the field, and instruction of employees in self-protective measures. In order to encourage personnel in safety practices, competitive prizes, posters, bulletins, and many other tools have been used.

The actual field work in safety is principally effected by spread superintendents and their foremen. It is the responsibility of these men to see that all operations are handled in the safest possible manner in order to insure a minimum injury rate and to prevent unnecessary destruction of property.

Transco Completes Financing Program

Claude A. Williams, president of Transcontinental Gas Pipe Line Corporation, Houston, Texas, has announced the consummation of final steps in the company's program to finance expansion of the line's capacity from 340,000,000 to 505,000,000 cu ft of gas a day.

In addition to the sale of $32,000,000 of 3¼ per cent first mortgage pipe line bonds, due 1970, to 18 insurance companies, the company has obtained $7,350,000 on a short term bank loan arranged with the Chase National Bank of New York, J. P. Morgan and Company, Inc. and Chemical Bank and Trust Company, with provision to borrow an additional $2,650,000, if needed, up to January 2, 1951.

The present transaction completes approximately $240,000,000 of financing for construction of Transcontinental's 1840-mile Texas-to-New York pipe line, which is scheduled to begin delivery of natural gas late this year. The company's capital structure, exclusive of short term borrowings, now comprises $175,000,000 first mortgage pipe line bonds, $26,500,000 interim notes, and 3,530,000 shares of common stock.

Williams announced that construction has begun on additional compressor stations, which, with enlargements previously authorized, will enable Transcontinental to expand its capacity to 505,000,000 cu ft.

Action Speeded on Gas Storage Application

Finding that "due and timely execution of its functions imperatively and unavoidably requires that the commission omit the intermediate decision procedure and render final decision in this proceeding," the Federal Power Commission has ordered that the intermediate decision procedure be omitted to speed action on the application of New York State Natural Gas Corporation and the Texas Eastern Transmission to construct large natural gas storage facilities in Pennsylvania.

Texas Eastern and New York State Natural Gas Corporation propose jointly to acquire, develop, and operate large underground storage facilities for natural gas in Westmoreland County, Pennsylvania. Combined cost of the project is $40,772,922—$20,250,130 for New York State Natural and $20,522,792 for Texas Eastern. A portion of the properties, within the Oakford Storage area, would be acquired from The Peoples Natural Gas Company, of Pittsburgh, an affiliate of New York State Natural. New York State Natural would build a 70-mile line in connection with the storage project, and Texas Eastern would construct a 35-mile pipe line and both applicants would jointly build and operate a 30,000-hp compressor station in the Oakford Area.

First Meeting Houston Pipeliners September 18

A new organization to be known as The Pipe Liners Club is now being formed in Houston for the mutual benefit of the members and the industry. The purpose of the club is to promote the science of pipe line engineering and the improvement of operating practices and will be similar to a club organized in Tulsa several years ago and still functioning.

The first meeting of the club will be held September 18, in the Houston Chamber of Commerce rooms in the Commerce Building. Preliminary organizational meetings have been under the chairmanship of J. E. Green of Shell Pipe Line Corporation.

The area in which the club is located is the headquarters of many large pipe line companies and the club should interest men in these companies who are concerned with design, operation, and other phases of the pipe line industry.

The program arranged for the September meeting will feature a movie, "Gas Goes to Market", a picture prepared by Tennessee Gas Transmission Company; an explanation of the objectives and operations of the club, and introduction of new members.

Plans for NACE New York Meeting Announced

Plans for the 1951 conference and exhibition of the National Association of Corrosion Engineers, to be held at Hotel Statler, New York, March 13-16, are well under way, according to information from L. B. Donovan, Consolidated Edison Company of New York, Inc., general chairman.

Prof. Norman Hackerman of the University of Texas, Austin, chairman of the technical program committee for the conference has projected arrangements for 39 papers.

The tentative technical program is:

Tuesday, March 13

2 to 3 p.m.—Corrosion principles symposium, one paper.

3:10 to 5 p.m. — Water industry symposium, 3 papers. Food industry symposium, 3 papers.

Wednesday, March 14

9 to 12 noon—Pipe line industry symposium, 4 papers. Chemical industry symposium, 4 papers.

2:30 to 5 p.m.—Transportation industry symposium, 4 papers. Protective coatings symposium, 4 papers.

Thursday, March 15

9 to 12 noon—Oil and gas industry symposium, 4 papers. Cathodic protection symposium, 4 papers.

2:30 to 5 p.m.—Electrical and communications industries symposium, 4 papers.

Symposium on industrial use of corrosion inhibitors, 4 papers.

Friday, March 16

9 to 12 noon—Round table on general corrosion problems. Round table on pipe line and underground corrosion.

Symposia Personnel

Chairmen and co-chairmen of symposia who have accepted include:

Oil and gas industry symposium: T. S. Zajac, Shell Oil Company, Houston, Texas, chairman; H. E. Waldrip, Gulf Oil Corporation, Houston, Texas, co-chairman; E. Q. Camp, Humble Oil and Refining Company, Baytown, Texas, co-chairman.

Pipe line industry symposium: S. S. Smith, Shell Oil Company, New York, chairman; W. E. Huddleston, Huddleston Engineering Company, Bartlesville, Oklahoma, co-chairman; I. B. Tietze, Phillips Pipe Line Company, Bartlesville, Oklahoma, co-chairman.

Protective coatings symposium: Kenneth Tator, Kenneth Tator Associates, Coraopolis, Pennsylvania, chairman; C. G. Munger, Amercoat Corporation, South Gate, California, co-chairman; Raymond P. Devoluy, C. A. Woolsey Paint and Color Company, Inc., New York, co-chairman.

Transportation industry symposium: Merritt A. Williamson, Pullman-Standard Car Manufacturing Company, Hammond, Indiana, chairman; Otto E. Kirchner, American Airlines, New York, N. Y., co-chairman; Joseph Winlock, The Budd Company, Philadelphia, Pennsylvania, co-chairman.

Electrical and communications industry symposium: Kenneth G. Compton, Bell Telephone Laboratories, Murray Hill, New Jersey, chairman; Walter C. Honecker, Indiana Bell Telephone Company, Indianapolis, Indiana, co-chairman; H. M. Trueblood, Dobbs Ferry, New York, co-chairman.

Industrial use of corrosion inhibitors symposium: Aaron Wachter, Shell Development Company, Emeryville, California, chairman; Morris Cohen, National Research Council, Ottawa, Canada, co-chairman; John W. Ryznar, National Aluminate Corporation, Chicago, Illinois, co-chairman.

Chemical industries symposium: W. Z. Friend, International Nickel Company, Inc., New York, chairman; Mars G. Fontana, Ohio State University, Columbus, Ohio, co-chairman; F. A. Rohrman, University of Colorado, Boulder, Colorado, co-chairman.

Assisting Dr. Hackerman as co-chairman of the technical program are R. L. Bullock, Interstate Oil Pipe Line Company, Tulsa, Oklahoma; G. W. Seagren, Mellon Institute, Pittsburgh, Pennsylvania, and Aaron Wachter, Shell Development Company, Emeryville, California.

Cathodic protection symposium: Sidney E. Trouard, New Orleans Public Service, Inc., New Orleans, Louisiana, chairman; A. W. Peabody, Ebasco Services Incorporated, Jackson, Mississippi, Y. W. Titterington, Dowell Incorporated, Tulsa, co-chairmen.

Corrosion principles symposium: H. H. Uhlig, Massachusetts Institute of Technology, chairman.

Round table on general corrosion problems, F. L. LaQue, International Nickel Company, Inc., New York, chairman.

Round table on pipe line and underground corrosion, R. L. Bullock, Interstate Pipe Line Company, Tulsa, chairman.

G. E. Seidel, Amercoat Corporation, Chicago, chairman of the exhibition committee reports there will be 106 booths and that he already has many requests for space.

Assisting Seidel are Clark A. Bailey, Johns-Manville; Bo Bardsley, Crutcher-Rolfs-Cummings, Inc., and Milton M. Bowen, Hill-Hubbell Division, General Paint Corporation.

The arrangements committee is headed by H. L. Hamilton, Keystone Pipe Line Company, Philadelphia, who has appointed the following chairmen of sub-committees: Registration and information, Fred Kuhlman, Consolidated Edison Company of New York; hotel and meeting rooms, F. J. LeFebvre, Electro Rust-Proofing Company; entertainment, Linden Stuart, Jr., Barrett Division, Allied Chemical and Dye Corporation; ladies committee, Mrs. Florence Rolph, Willard-Hawes Company; printing, George Hull, Jr., Anglo-American Paint Company; conference coordination, T. P. May, The International Nickel Company, Inc.; hospitality, W. Aretz, W. A. Briggs Bitumen Company.

Pipe Line Expansion Curbs Petroleum Cost

Rapid expansion of pipe lines since the end of World War II has helped the petroleum industry keep the cost of its products near the bottom of the commodity price index, a Sun Oil Company representative declared recently at Buckhannon, West Virginia.

Longer and larger diameter pipe lines are constantly lowering the cost per ton-mile of moving petroleum products and increasing the efficiency of the oil industry's complex transportation system, according to Ben Esler Eaton, of Sun's land department, speaking at a transportation seminar at West Virginia Wesleyan College.

"Pipe line operations are already in the push-button stage," he added, pointing out that as many as 33 different products can be transported one after another through a line operated by a central control system.

Eaton asserted that the oil industry was quick to make commercial use of atomic energy in pipe line operations, employing radioactive tracers and Geiger counters to follow the course of separate "batches" of oil moving through the lines.

He described the oil industry's transportation system as "part of an assembly line in a mass production industry" and warned that to divorce pipe lines from the other segments of the system "would strike at the heart of one of America's most efficient and progressive industries."

Advocates of divorcement fail to take into consideration the financial risks involved in building a crude oil pipe line into a newly-discovered oil field, he explained.

"The builder of the pipe line takes a very definite risk because he has no guarantee as to the volume of oil that can be transported from any particular field," Eaton pointed out.

"There is no guarantee that any specific pipe line will repay the cost of its construction," he went on. "The useful life of a crude line is problematical."

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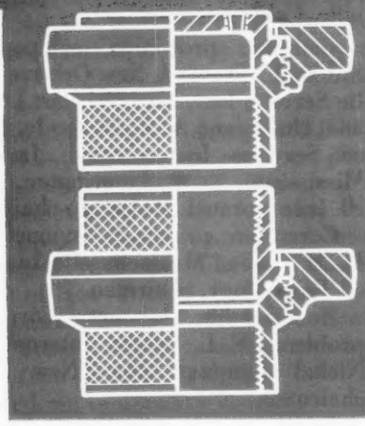

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A Horse Named Laddie Finds the Small Gas Leaks

In these days of jet-planes and atom bombs, a horse is probably the last thing a person would expect to see in a large modern business. A few are used, however, in the pipe line operations of the Cities Service Gas Company and one of them is a very intelligent and loyal worker. His name is Laddie and he is a tall, proud, eight year old palomino belonging to Horace Hull of Matfield Green, Kansas. Hull uses him to ride along the company pipe line looking for leaks and other trouble. Laddie is continuously looking for gas leaks and when he discovers a leak too small to be noticed by his rider, he stops and waits until his rider examines the pipe where the leak is located. Each morning, when it is time to start the patrol, Laddie begins to neigh and continues until Hull reports to the stables. The most remarkable part of it, especially in these times, is that Laddie is not even on the payroll.—Cities Service News Letter.

Transco Directed to Supply Communities

Supplementing its order of April 28, granting a certificate of public convenience and necessity to the Transcontinental Gas Pipe Line Corporation to increase the capacity of its Texas-to-New York pipe line and extend the system's service, the Federal Power Commission has ordered that company to sell and deliver natural gas to the South Carolina Gas Company, Gaffney, South Carolina, to the cities of Lavonia, Buford, and Sugar Hill, Georgia, and to the city of Gainesville, Georgia, should the city elect to construct and operate its own local distribution system, or to the Georgia Gas Company for distribution in Gainesville if the city elects not to construct its own distribution system.

Hearing September 11 on United Gas' Proposal

The Federal Power Commission has scheduled a public hearing to begin September 11 in Washington, D. C., on the application of United Gas Pipe Line Company, of Shreveport, Louisiana, for authorization to build approximately 1005 miles of new natural gas pipe line in Texas, Louisiana, and Mississippi.

The proposed expansion program, which would increase the delivery capacity of United's transmission system by more than 800,000,000 cu ft daily, is estimated to cost approximately $111,510,000.

API Pipe Line Conference To Be Held Sept. 11-13

New techniques and developments in petroleum pipe line operations will be discussed in St. Louis, Missouri, at an American Petroleum Institute Products Pipe Line Technology Conference. The conference will be held in Hotel Lennox on September 11, 12, and 13. Symposiums will be held on the first two days, while the third day will be taken up with a field trip to four pipe line stations in the St. Louis vicinity. The meeting is sponsored by the Sub-Committee on Products Pipe Line Technology of the Division of Transportation. The group is headed by J. W. deGroot, president of Tuscarora Oil Company, Ltd., Harrisburg, Pennsylvania.

The meeting will get underway Monday morning, September 11, with a symposium on operations of automatic, semi-automatic, and remotely controlled pipe line pumping stations. H. E. Fisher, of Standard Oil Company (Indiana), Chicago, will speak on fully automatic stations; R. F. Hadley, of Susquehanna Pipe Line Company, Philadelphia, will discuss semi-automatic stations, and S. S. Smith, of Shell Oil Company, NewYork, will describe remotely controlled stations.

Speakers for the afternoon session and their topics are:

E. B. Dunn, Keystone Pipe Line Company, Philadelphia, "The Use of Microwave for Pipe Line Communications"; Norris Plank, Shell Oil Company, New York, "A Development in Metering Practices"; R. H. Lynch, Keystone Pipe Line Company, Philadelphia, "Economics of a Pipe Line Design"; F. O. Stivers, Jr., Humble Pipe Line Company, Houston, Texas, "Products Pipe Line Hydraulics"; C. C. Keane, Great Lakes Pipe Line Company, Kansas City, Missouri, "Operational Costs, Diesel versus Electrically Operated Units."

Symposium speakers and their topics for the Tuesday morning session are:

F. M. Watkins, Sinclair Refining Company, Independence, Kansas, "Application of Inhibitor in Products Pipe Line Operations"; W. G. Horstman, Plantation Pipe Line Company, Atlanta, Georgia, "Mechanical Seals for Main Line Pumps"; T. L. Opie, Socony-Vacuum Oil Company, Plainfield, New Jersey, "Ideas in Mobile Transportation and Maintenance Equipment"; G. T. Jennings, Phillips Petroleum Company, Bartlesville, Oklahoma, "Procedures in Cutting, Tapping, Maintaining and Repairing Leaks in Field Pipe Lines Handling L.P.G. Products"; and R. T. Henderson, The Standard Oil Company (Ohio), Cleveland, Ohio, "Emergency Fire Fighting Equipment for Products Pipe Line Stations and Terminals."

The afternoon session will be a panel affair during which questions submitted in writing during the course of the meeting will be taken up and discussed by a group of experts. Members of this panel will be L. S. Wrightsman, of Humble Pipe Line Company, L. A. Baxter, of Keystone Pipe Line Company, D. C. Glass, of The Pure Oil Company, S. S. Smith, of Shell Oil Company, J. E. Ford, of Susquehanna Pipe Line Company, C. C. Keane, of Great Lakes Pipe Line Company, and W. G. Horstman, of Plantation Pipe Line Company.

Wednesday's field trip will leave Lennox Hotel at 8:00 a.m., and return by 5:30 p.m. Bus transportation is planned for those making the trip. Stops will be made at Shell Oil Company's products pipe line stations at Wood River, Vandalia, Barnett, and New Douglas. Three of these stations are electrically operated and the fourth is diesel powered. Douglas station is remotely controlled from New York.

Ed Morrill President Mid-Valley Pipeline

Election of Edward F. Morrill as president of the Mid-Valley Pipeline Company has been announced by William C. Kinsolving, newly elected chairman of board of directors.

Morrill, a vice president of Mid-Valley since the organization of the company in August, 1949, succeeds Kinsolving as president.

Kinsolving also announced plans to transfer the company's headquarters from St. Louis to Longview, Texas, effective immediately. Mid-Valley offices in Longview will be in the Bramlette Building. The company's offices in St. Louis will be closed on or before October 1.

Morrill, a native of Springfield, Illinois, and a graduate of Case Institute of Technology, class of 1929, has had wide experience in pipe line operations. After graduating from college he was employed for three years by the Ohio Bell Telephone Company and then joined The Standard Oil Company (Ohio). Starting as a service station employee, he later joined the transportation engineering division and ultimately became assistant manager of transportation operations and president of Sohio Pipe Line Company.

Begun last fall, the Mid-Valley's 1000-mile pipe line from Longview, Texas, to Lima, Ohio, is now nearing completion. Built at a cost of approximately $56,000,000 and owned jointly by Sun Oil Company and The Standard Oil Company (Ohio), the line will have a capacity of 150,000 bbl of crude oil a day.

Mexico May Build 700-Mile Gas Line

The Mexican government oil industry states it is studying the possibility of a new gas pipe line from the U. S. border area to connect with Mexico City. Pemex said the 700-mile line would cost about 250 million pesos ($29,000,000). It would run from the Reynosa gas fields to the Poza Rica oil field. A gas pipe line already runs from Poza Rica to the capital.

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PIPE LINE PROJECTS

Gas Line From Panhandle To Rocky Mountain Area

The Federal Power Commission has authorized Colorado Interstate Gas Company and Canadian River Gas Company to construct pipe line facilities that will carry additional natural gas to the Rocky Mountain market area.

The pipe line facilities involved in the authorization include a 215-mile, 20-in. line extending from the West Panhandle (Texas) gas field to Colorado's Kit Carson (Colorado) compressor station. Colorado said the line, which will deliver gas into its existing Lakin (Kansas)-Denver (Colorado) pipe line, is necessary in order to provide adequate natural gas for its resale customers in the Rocky Mountain market area.

In addition to the line, a 4800-hp compressor station will be built at the southern terminus, and a gasoline plant and dehydration plant will be constructed on the discharge side of the compressor station.

Estimated cost of the construction program is $10,160,200, plus an additional investment of approximately $3,697,400 in production and gathering facilities.

FPC Grants a Part of Mississippi Fuel's Request

The Federal Power Commission has issued an opinion and order authorizing in part the proposed expansion program of Mississippi River Fuel Corporation, of St. Louis, Missouri, but reopening the proceeding with respect to the company's natural gas supply. Further hearings will be held at a date to be fixed by the FPC.

The facilities authorized by the commission will increase the capacity of Mississippi's system from the presently authorized 266,000,000 cu ft per day to a new capacity of up to 300,000,000 cu ft. Mississippi had proposed to increase its system capacity to 375,000,000 cu ft daily.

The authorization includes the construction of a 40-mile, 18-in. line from a point near Dubach, Louisiana, to Mississippi's Perryville, Louisiana, compressor station, and 0.7 miles of 24-in. line and 4.6 miles of 12¾-in. line in a crossing of the Mississippi River in the metropolitan St. Louis area. The 40-mile line will connect Mississippi's system with additional gas reserves, and the river-crossing facilities will connect the system with new facilities now under construction by Laclede Gas Company of St. Louis.

The commission also authorized Mississippi to continue the operation of additional compressor units totaling 4100 hp at two compressor stations at Perryville, Louisiana, and West Point, Louisiana. The additional units have been in operation since the end of 1949 without authorization.

Total estimated cost of the facilities authorized by the commission, including the additional compressor units already in operation, is $3,143,995. The company was directed by FPC to begin construction so that the new facilities will be placed in operation by December 31.

The commission rejected Mississippi's plan to lease seven compressor stations that were to be built by Stupp Brothers Bridge and Iron Company. The seven new stations were to have a total installed capacity of 28,380 hp and were estimated to cost $5,392,200. Mississippi proposed to lease the stations for 28 years, with an option to extend the lease for another 10 years. "In this case," FPC said, " the record shows that no necessity exists for Applicant resorting to the proposed leasing arrangement, since the evidence shows that Applicant could readily finance the construction of the seven new compressor stations, if it desired to do so."

FPC said that the reopening of the proceeding will afford Mississippi an opportunity to amend its application and seek authority to acquire or construct, finance, and operate the proposed seven compressor stations instead of leasing them.

The commission stated that it is of the opinion that Mississippi does not now possess a supply of natural gas reasonably adequate to render the service proposed, but said: "In the light of the public demand and need for natural gas before us in this case, for which Applicant and its utility customers have an obligation and responsibility to serve, we are of the opinion that, though the record here clearly does not warrant the granting of 'the whole' of the amended application before us, good grounds exist for granting 'part' of the application."

Plantation Pipe Line To Spend $52,000,000

The Plantation Pipe Line Company, Atlanta, Georgia, announces that $52,000,000 will be spent on a construction program. Included in the program will be the laying of 432 miles of 18-in. and 275 miles of 14-in. to parallel the company's main line. In addition, necessary pumping equipment, tankage, and terminal facilities will be installed. This will increase the capacity of the system from 95,000 bbl to 167,000 bbl a day.

Plantation's system consists of a products trunk line from Baton Rouge, Louisiana, to Greensboro, North Carolina, with laterals to various points in the southeastern states. The company's stock is wholly owned by three major oil companies, Standard Oil Company (New Jersey), Standard Oil Company (Kentucky), and Shell Oil Company. It operates as a common carrier, and, in addition to transporting products for its three stockholders, at present transports products for eight other companies.

Georgia Natural Gas Files New Application

Georgia Natural Gas Company, of Albany, Georgia, has filed a new application with the Federal Power Commission proposing to construct a pipe line system to serve natural gas markets in southwestern Georgia and Tallahassee, Florida.

The application, similar to one filed by the company on March 27, 1950, and subsequently withdrawn, also asks the FPC to direct Southern Natural Gas Company, of Birmingham, Alabama, to provide and sell to Georgia Natural an adequate supply of natural gas for the proposed project.

Georgia Natural's proposed transmission system would connect with Southern Natural's facilities near Phenix City, Alabama, and extend to Tallahassee. Estimated overall cost of the project is $5,100,000.

Cities and towns to be served include Americus, Cordele, Albany, Moultrie, Thomasville, Bainbridge, Cairo, Quitman, and Valdosta, all in Georgia, and Tallahassee, Florida. Georgia Natural estimates its annual demand at 9,167,098,000 cu ft, with an estimated maximum day, firm, of 30,000,000 cu ft.

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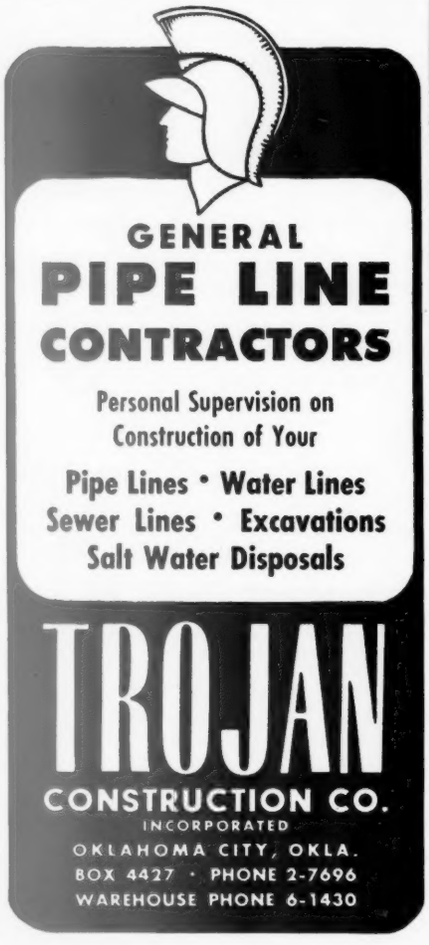

Ohio Fuel Gas Company To Build Short Line

The Federal Power Commission has issued a certificate of public convenience and necessity to The Ohio Fuel Gas Company authorizing it to construct and operate approximately 22 miles of 16-in. natural gas transmission pipe line in the vicinity of Dayton, Montgomery County, Ohio. The line will extend from the junction of Ohio Fuel's lines A and A-75, near Centerville, to the junction of lines Z-50 and Z-167, near Englewood, passing west of the City of Dayton, and will have a capacity of 75,000,000 cu ft per day. The commission at the same time authorized the removal of the company's 330-hp Vandalia compressor station, which is attached to lines Z-167 and Z-45 near Dayton.

Ohio Fuel proposes to begin construction of the pipe line about September 1 and to have it completed and in operation by November 1.

Venezuelan Gas Line Construction Begins Oct. 1

On his 20th trip to Venezuela, E. Holley Poe has finally seen his dream come true. He is the man with the vision for the construction of a pipe line to salvage the valued by-product of Venezuela's No. 1 industry and to turn it into a valuable source of fuel for the industrial development of the country.

On October 1, it is expected work will begin on the construction of the pipe line that will provide Caracas with its first fuel gas. The entire project will cost more than $1,000,000 although the primary construction costs will be about $5,000,000.

The gas will come principally from the regions around Las Mercedes and Tucupido almost 100 miles from Caracas. It will take from 10 to 11 months for completion.

Hearing on Texas Gas Transmission Application

A public hearing before the Federal Power Commission began September 1, in Washington, D. C., on the application of the Texas Gas Transmission Corporation for a certificate of public convenience and necessity to install and operate 5460 additional horsepower in existing natural gas compressor stations, to construct a new 4500-hp compressor station and to transport for Texas Eastern Transmission Corporation, (1) up to 60,000,000 cu ft of natural gas a day until November 1, 1951, or until Texas Eastern shall have completed certain new facilities for which it has asked authorization in Docket No. G-1012, whichever is earlier, and (2) up to 34,400,000 cu ft of gas per day for a period beginning with November 1, 1951, and ending two years from the date of first delivery of the 60,000,000 cu ft, or until Texas Eastern has completed facilities for which it has applied to the commission for authority to construct in Docket No. G-1012, whichever is earlier. Total cost is estimated at $2,108,887.

Arkansas Louisiana Gas Proposes Short Line

The Federal Power Commission has set a hearing for September 11 in Washington, D. C., on the application of Arkansas Louisiana Gas Company, of Shreveport, Louisiana, for authorization to build pipe line facilities for the purpose of delivering natural gas to the Crossett Lumber Company for consumption in its plant at Crossett, Arkansas.

Arkansas Louisiana is proposing to construct and operate an interconnection, and measuring and regulating station on its transmission line in Union County, Arkansas. The facilities would connect Arkansas Louisiana's system with an 8⅝-in. pipe line, to be constructed by the lumber company and operated by Arkansas Louisiana, extending about 30.3 miles to the Crossett plant.

Pipe Line From Alberta to Pacific Coast Considered

An oil pipe line from Alberta's fields to the Pacific Coast is under consideration but no definite plans have yet been made, according to G. L. Stewart, president of Imperial Oil Ltd.

The West Coast market in British Columbia would not be large enough to make a pipe line economical, Stewart said. A portion at least of the northwest market of the United States would also have to be tapped.

The Vancouver market would only take about 35,000 to 40,000 bbl a day, of which 14,000 bbl would be bunker fuel and this would not in itself be a large enough outlet to justify a pipe line, Stewart said.

Alberta, he declared, needed more markets. Imperial's first step after getting the Interprovincial pipe line (Edmonton to Superior, Wisconsin) into full operation would be to increase its capacity by 50 per cent. The line, as now being set up, will take 95,000 bbl a day; however, only 50,000 bbl will reach beyond the prairies to contact the eastern Canada market. For the first year of operation, lake head terminal problems of storage and tankers will cut this to a net of about 35,000 bbl a day beyond the limits of the western Canadian plains.

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240-Mile Gas Line Proposed for Arkansas

MidSouth Gas Company, of Little Rock, Arkansas, has filed two applications with the Federal Power Commission, one seeking authorization for the acquisition of pipe line facilities, and the other proposing the construction of a pipe line system, all in Arkansas.

The first application, filed jointly by MidSouth and Arkansas Power and Light Company, also of Little Rock, seeks authorization for MidSouth to acquire from Arkansas Power its existing pipe line system in Lawrence, Craighead, Independence, Jackson, White, Ashley, Chicot, and Desha counties, Arkansas.

The system includes 26 miles of main line pipe and distribution systems serving 20 towns in eastern Arkansas. Estimated purchase price for the entire system is $1,825,200.

MidSouth's second application sets forth plans for the construction of a natural gas transmission system, consisting of about 240 miles of pipe, in Greene, Poinsett, Crittenden, St. Francis, Lee, Phillips, Monroe, Woodruff, and Cross counties, Arkansas. Estimated cost of the system, including the acquisition from Arkansas Power and Light, and the Helena propane air system of Arkansas Utility Company, is $10,665,500.

The northern portion of the system would extend from a connection with Mississippi River Fuel Corporation's line at Biggers, Arkansas, in a southeasterly direction about 26 miles to Paragould, Arkansas. The southern section of the proposed system would connect with Texas Gas Transmission Corporation's system at Helena, Arkansas, and would generally extend northerly, with several forks, to carry gas to 21 communities.

Sales of natural gas for the combined systems to be constructed and purchased are estimated at 36,600,000 cu ft in 1950 and at 2,968,500,000 cu ft in 1953.

Texas Eastern Request Scheduled for Hearing

The Federal Power Commission has set a hearing to begin September 1 in Washington, D. C., on the application filed June 5, 1950, by Texas Eastern Transmission Corporation for a certificate of public convenience and necessity authorizing the sale and delivery to its existing customers west of Compressor Station No. 20 of additional volumes of natural gas. Compressor Station No. 20 is in southwestern Pennsylvania.

The commission has granted the company's request that this application be heard under its shortened procedure, provided no request to be heard, protest or petition raising an issue of substance is filed. After a noncontested hearing the commission may dispose of the proceeding forthwith.

The commission has denied the petitions of the National Coal Association, United Mine Workers of America, Anthracite Institute, Fuels Research Council, Inc., and The Railway Executives Association asking leave to intervene in this case, finding that none of these petitions was filed within the time prescribed by the commission's rules of practice and procedure and good cause has not been shown for permitting the late filing.

Prince Georges Gas To Construct Line

The Federal Power Commission has issued a certificate of public convenience and necessity authorizing Prince Georges Gas Corporation to construct and operate approximately 20 miles of 22-in. natural gas pipe line between a point of connection with the pipe line facilities of Atlantic Seaboard Corporation and applicant's storage and compressor station.

The new pipe line will be used, Prince Georges Corporation states, to transport increased volumes of natural gas from Atlantic Seaboard's facilities for delivery to its parent, the Washington Gas Light Company, and another subsidiary, the Washington Gas Light Company of Maryland.

The facilities authorized, it is estimated, will have an ultimate delivery capacity of 122,000,000 cu ft of natural gas a day.

River Crossings Are Temporarily Authorized

The Federal Power Commission has granted temporary authorization to Texas Gas Transmission Corporation of Owensboro, Kentucky, for the construction of two 3.4-mile, 20-in. submarine pipe lines across the Mississippi River in the Greenville, Mississippi, area.

The authorization also includes the construction of 1.93 miles of 26-in. pipe line to interconnect the submarine lines with Texas Gas' 18-in. and 26-in. systems. Estimated cost of the construction is $1,457,959.

Texas Gas said the new lines are required because of the failure during the early spring of 1950 of four of its submarine pipe line crossings under the Mississippi in the Greenville area. The failure, the company said, has caused an excessive pressure drop at the river crossing, which has resulted in a serious decrease in capacity of its two systems.

Acme Natural Given Authority to Build

The Federal Power Commission has authorized Acme Natural Gas Company, of Butler, Pennsylvania, to construct and operate pipe line facilities to supply natural gas to three industrial consumers in the Butler area.

The commission also directed The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania, to connect its pipe line system with the facilities proposed to be built by Acme and to sell and deliver gas to the latter company. Manufacturers is a subsidiary of The Columbia Gas System, Inc.

Acme's proposed pipe line project will include approximately 19 miles of 10-in., 1200 ft of 8-in., and 3800 ft of 6-in. line. Acme has estimated it will require as much as 18,000,000 cu ft of natural gas a day from manufacturers for desired service.

Authority to Sell Facilities Asked

The Manufacturers Light and Heat Company and Natural Gas Company of West Virginia, both of Pittsburgh, Pennsylvania, and subsidiaries of The Columbia Gas System, Inc., have filed a joint application with the Federal Power Commission in connection with the proposed sale by Natural of all its property in West Virginia and Pennsylvania to Manufacturers.

Natural's transmission facilities, situated in Washington and Greene counties, Pennsylvania, and Ohio and Marshall counties, West Virginia, consist of three 8-in. pipe lines and one 10-in. line extending generally from production and storage fields in Pennsylvania to the Wheeling, West Virginia, area; certain minor transmission lines, and two small compressor stations. The application seeks authorization for Natural to sell, and for Manufacturers to acquire and operate, these facilities. In addition, the proposed transaction would include other facilities used in the production, storage, transmission, and distribution of gas.

The total purchase price of the facilities as of February 28, 1950, is $3,231,833.74, the application states. In addition to the property to be sold, Natural also has production, transmission, and distribution facilities in northeastern Ohio.

The application says that if Manufacturers is permitted to acquire the Pennsylvania and West Virginia facilities of Natural, the present facilities of both companies in the area can be integrated and more efficient and economical service can be given to customers of both companies.

With the PIPE LINE CONTRACTORS

Ray L. Smith and Son, Inc., El Dorado, Kansas, is laying pipe on 104 miles of 18-in. for Commonwealth Natural Gas Corporation. The section is from Stanardsville to Richmond, Virginia. In addition, 84 miles of 12-in., 20 miles of 8-in., and various laterals will be laid for Commonwealth Natural between Richmond and Newport News. Two spreads are on the job. Spread No. 1 has its headquarters at Orange, Virginia. Don C. Smith is the superintendent. The office and warehouse for Spread No. 2 is at 5606 West Broad Street, Richmond, on Highway 250. Wm. G. (Bill) Frost is spread superintendent. Ray Leigh Smith is general superintendent over both spreads.

Britton Contracting Company, 93 South Main Street, Washington, Pennsylvania, will complete sometime this month the 111 miles of 22-in. from Russellville, Kentucky, to a point approximately 25 miles south of Louisville, for Mid-Valley Pipeline Company. Herb Britton is general superintendent, T. C. Pierce spread superintendent, and E. Howard Smith office manager.

Mahoney Contracting Company, Hersee Building, Mt. Pleasant, Michigan, has begun work on 186 miles of 26-in. between Tuscola and Joppa, Illinois, on the Trunkline Gas Supply Company system.

For Michigan Gas Storage Company, 84 miles of 22-in. is being laid from St. Johns to Marion, Michigan.

Associated Pipe Line Contractors, Inc., 3272 Westheimer Road, Houston, Texas, is constructing 84 miles of 18-in. between Gorham, New Hampshire, and the Canadian border for Portland Pipe Line Company. Lacy Walker is spread superintendent.

In the East, 75 miles of 30-in. are being laid for Transcontinental Gas Pipe Line Corporation, from Rockville, Maryland, to Conawingo, Pennsylvania. The field office is at Towson, Maryland. J. A. Williamson is general superintendent and Cecil Rogers spread foreman. W. H. Flowers is in charge of the double-jointing rack.

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, has now completed approximately 50 miles of the 85 miles of 18-in. on the Portland Pipe Line Company job. The section under contract is between Portland, Maine, and Gorham, New Hampshire. The field office is at Norway, Maine. H. A. Wylie is superintendent and Lisle W. Chambers paymaster.

It is expected that September 15 will see main line work completed on the Transcontinental Gas Pipe Line Corporation work from Edgewater to Elizabeth, New Jersey, of 23 miles of 30-in. This construction has been slow due to the congested nature of the area through which the line is being laid. The field office is at Harrison, New Jersey. Pete Thurman is superintendent and Joe Freeman paymaster.

Clearing of right-of-way began soon after the middle of August on 80 miles of. 26-in. for Transcontinental from Refugio, Texas, south. A field office has been opened at Edna. "Panama" Shiflett is superintendent and Earnest Smith paymaster.

In Mississippi, 43 miles had been laid (August 21) on the 90-mile section of 30-in. from Sunflower County to Marshall County for Tennessee Gas Transmission Company. Two spreads are in the field. The one working out of Batesville, Mississippi, is under the supervision of Raymond Law with Gene Gohring the paymaster. The other spread has its headquarters at Cleveland, Mississippi. Louis Visentine is superintendent and V. C. Eason paymaster.

Eastern Construction Company, 1801 Mercantile Bank Building, Dallas, Texas, is completing a 25-mile section near Elizabethtown, Kentucky, on the Mid-Valley Pipeline Company system, assisting Britton Contracting Company. Mid-Valley officials have pulled all the stops in an effort to get the line in operation ahead of schedule. Eastern completed its regular section of 155 miles between Russellville, Kentucky, and Hornsby, Tennessee, 50 days ahead of time. Fred Byers is general superintendent and J. W. Arthur field office manager.

Bechtel-Price-Conyes, 220 Bush Street, San Francisco, California, are now working in the vicinity of Shafter, California, on the Pacific Gas and Electric Company line, 506 miles of 34-in. between Topock, Arizona, and Milpitas, California. The double-ending plant is in operation at Coalinga and a stationary wrapping plant at Tehachapi. R. L. Bowman is general superintendent; M. V. Scott, manager, mainline office, P.O. Box 606, Shafter, California; Steve Valline, administrative manager, San Francisco.

Texas-Southern Contracting Company, 804 Dan Waggoner Building, Fort Worth, Texas, has laid about a third of the 92 miles of 30-in. between Deweyville and Porters, Texas, on the Transcontinental Gas Pipe Line Corporation job. Merle Tatom, spread foreman, recently suffered a broken leg at the knee and has been in the hospital at Liberty. He isn't expected to be back on the job for three or four months. In the meantime his father, "Red" Tatom, is subbing for him. The field office for this spread is at Liberty with Lee Price the office manager. Laying of the Trinity and Sabine River crossings are being handled from the same office with "Borger Red" McMenamy the spread foreman. The Trinity is being finished and the gang is moving in on the Sabine.

The 50 miles of 18 and 20-in. near Eunice, Louisiana, for Transcontinental has been laid and there is only a little clean-up work to be done. The office for this work has been at Crowley with Jimmy Reid spread superintendent and Pat Rogan office manager.

A new job is 24 miles of 16-in. for United Gas Pipe Line Company from a point in Cameron Parish, Louisiana, to Gulf's refinery at Port Arthur, Texas. The hardest part of this job is laying the line through Sabine Lake, or Mud Lake as the construction gang has named it. F. O. "Banty" Traweek is the superintendent and Q. B. Davis, Jr., office manager. The crew is working out of Port Arthur.

Fred Mannix and Company, Ltd., Calgary, Alberta, Canada, reports the following:

For Interprovincial Pipe Line Company, 126 miles of 20-in. between Edmonton and Hughenden. This work is being done under the name of **Mannix Pipe Line Company** and approximately 95 miles have been completed. The field office is at Camrose with A. T. Beaman as superintendent.

For Montreal Pipe Line Company, 68 miles of 18-in. between Highwater and Montreal, Quebec. About 35 miles have been completed. The office is at Cowansville with B. V. Elliott the superintendent. The line is being laid under the name **Sparling-Fowler-Campbell.**

Also under the name **Sparling-Fowler-Campbell,** 80 miles of 10-in. are being laid from Gretna to Winnipeg, Manitoba. Ray Stokes is superintendent. The field office is at Altona.

▸ **Latex Construction Company,** 2707 Ferndale Place, Houston, Texas, completed late in August, 68 miles of 30-in. from West Monroe to Natchitoches, Louisiana, for Tennessee Gas Transmission Company. The spread then moved to Eudora, Arkansas, to lay 33 miles for the same company between the Mississippi River and Jones, Louisiana. This spread has W. H. Hayes as superintendent, M. L. Thompson assistant superintendent, J. C. Strickler and J. B. Stoddard in the office.

Other jobs completed in August were 71 miles of 12 and 16-in. for Tennessee Gas between Kinder and Grand Chenier, Louisiana; and 85 miles of 4 to 14-in. gathering lines for Transcontinental Gas Pipe Line Corporation in South Louisiana.

The contractor began laying pipe August 20 on 95 miles of 20-in. for Tennessee Gas between Natchitoches and Kinder, Louisiana. The right-of-way work has all been completed. Headquarters are at Leesville, with J. B. Latham the superintendent.

Between Sale and Kinder, Louisiana, preliminary work began August 10 on 105 miles of 16-in. for Tennessee Gas. The field office is at Franklin. H. L. Leake is superintendent and S. B. Harrison office manager.

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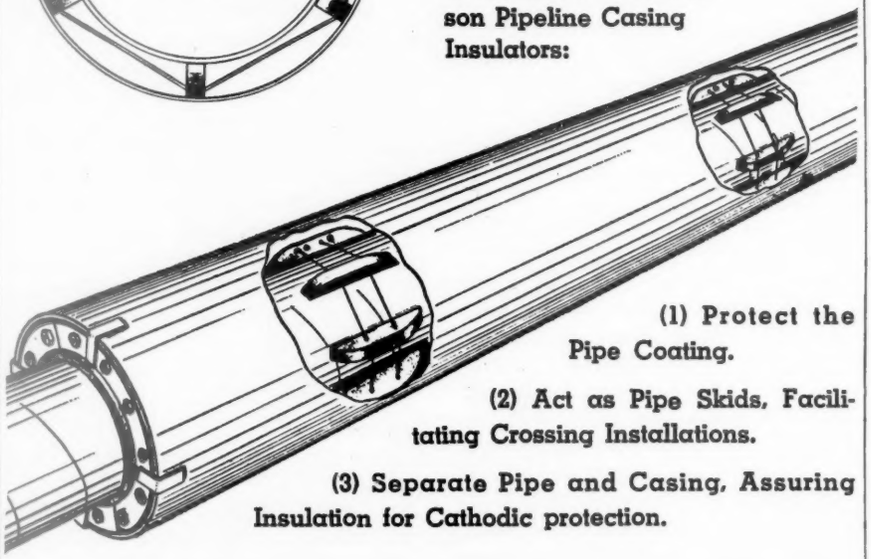

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Right-of-way work began August 1 and pipe laying September 1 on 11 miles of 8-in. for American Petroleum Company from Sour Lake to Arriola, Texas. J. B. Latham is superintendent and W. M. Keller office manager. The field office is at Sour Lake.

Work is now under way and expected to be completed about October 1 on 10 miles of 26-in. for Tennessee Gas Transmission Company in the vicinity of the Greenville Mississippi River bridge. This work consists of land lines approaching the Greenville bridge and four lines suspended on the bridge and is combined with removing the present 18-in. and 16-in. bridge lines. Headquarters are being made at Lake Village, Arkansas. H. E. Murphy is superintendent and J. H. Mabry office manager.

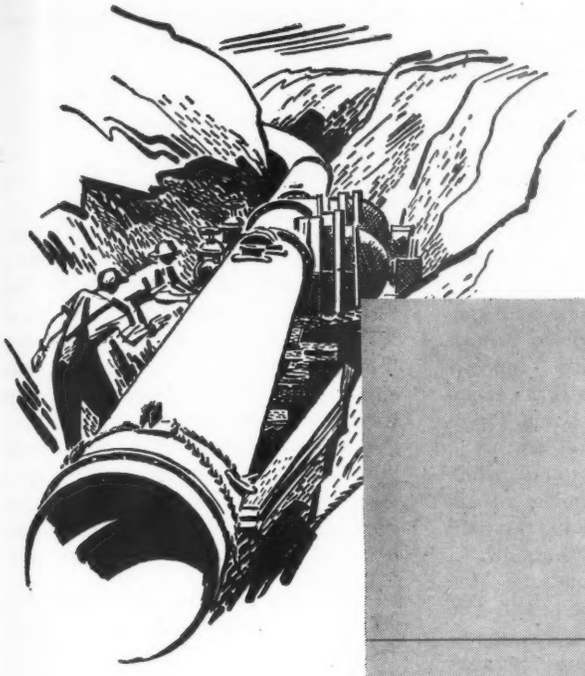
Two 16-in. submarine lines across the Mississippi River just below the Greenville bridge were started last winter but were not completed due to flood conditions. This work, which also is for Tennessee Gas, was resumed August 15. The field office is at Greenville, Mississippi. J. A. Cantrell is superintendent and A. E. Stremmel office manager.

▸ **Reese Brothers Construction Company,** Hugoton, Kansas, is installing a gathering system for Northern Natural Gas Company in the vicinity of Ulysses and Garden City, Kansas. Total mileage will be 85, consisting of 4, 6, 8, and 12-in. pipe. Paul G. Reese is superintendent, Ed Reese spread foreman, Gale Reese welding foreman, and Chet Beighle office manager.

▸ **Conyes Construction Corporation,** 2884 San Pablo Avenue, San Pablo, California, is laying 340 miles of 12-in. pipe between Worland and Baker, Montana, for the Montana-Wyoming Gas Company. Al Poggi is general superintendent and Fred King office manager.

▸ **Brown and Root, Inc.,** 4100 Clinton Drive, Houston, Texas, is constructing an 80-mile, 10-in. oil line for Pan American Pipe Line Company. The line is being laid from Scurry County, Texas, through Mitchell, Sterling, Tom Green, and Irion counties. An 800-hp compressor station will be built north of Colorado City by the same contractor.

▸ **Trojan Construction Company,** Box 4427, Oklahoma City, Oklahoma, is taking up 190 miles of 10-in. pipe that was formerly owned by Shell Pipe Line Corporation, extending eastward from Springfield, Missouri. Maurice W. Crawford is superintendent and Don Wilson office manager.



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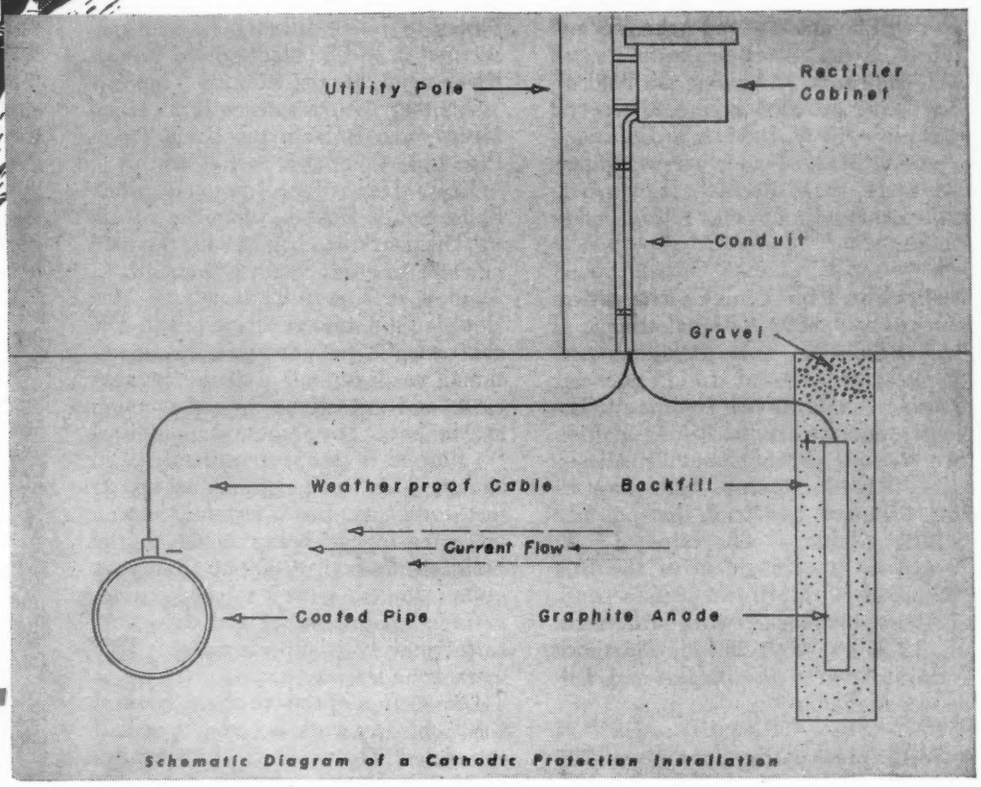

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▸ **Bechtel Corporation, H. C. Price Company,** and **Midwestern Constructors, Inc.,** in a joint venture, have contracted 409 miles of 30-in. on the Texas Illinois Natural Gas Pipeline Company system, the line that will be laid from the Corpus Christi, Texas, area to the vicinity of Joliet, Illinois. The 409 miles will lie between the Ozark Mountains and the lowlands of the Mississippi River. Crossings also will be made of the Arkansas and White Rivers. Work began in August near Newport, Arkansas, the field office being situated at the Airport at that place. E. W. Davis is project manager, A. M. Berlander general superintendent, S. D. Bechtel, Jr., superintendent, and E. C. Elting office manager.

▸ **Sheehan Pipe Line Construction Company,** 529 National Bank of Tulsa, Building, Tulsa, Oklahoma, is laying 180 miles of 18-in. pipe for Southern Natural Gas Company. The construction work is being done in two sections: From Gwinville, Mississippi, to the Mississippi-Alabama state line, 95 miles, and from that point to Selma, Alabama, 85 miles. J. W. Brown is superintendent of the first spread, and C. M. Brown of the second.

About October 1, work will begin on 32 miles of 16-in. for Northern Natural between Wetumpka and Tallassee, Alabama.

▸ **Williams-Austin Company,** 707 Grant Building, Pittsburgh, Pennsylvania, began right-of-way work August 21 on 21 miles of 20-in. for New York State Natural Gas Corporation, between Tonkin station and Bakerstown, Pennsylvania. The pipe arrival date is September 26. Ralph Gaddy is superintendent.

Pipe is scheduled to arrive September 16 for 25½ miles of 6 and 10-in., which will be laid from Elwood to Butler, Pennsylvania, for Acme Natural Gas Company. Right-of-way work began September 1. Leman Creech is superintendent.

For Central Kentucky Natural Gas Company, 42 miles of 20-in. are being laid from the North Means compressor station to Foster, Kentucky. This work has just got under way. The field office and warehouse are at Mt. Sterling, Kentucky. Howard Bauer is superintendent.

▸ **Midwestern Constructors, Inc.,** 105 North Boulder Street, Tulsa, Oklahoma, are keeping extremely busy with several jobs going at the same time. Two spreads were scheduled to begin work September 1 on the new Texas Illinois Natural Gas Pipeline Company system. Schedule 1 consists of approximately 100 miles of 26-in. from LaGloria to Refugio, Texas. Schedule 11 is approximately 100 miles of 30-in. from the Mississippi River to Effingham, Illinois. Texas Illinois has awarded the company two other spreads but work on these will not begin until in 1951. These are Schedule 12, 100 miles of 30-in. from Effingham to Sibley, Illinois, and Schedule 13, 92 miles of 30-in. from Sibley to Joliet, Illinois. In addition, a crossing will be made of the Illinois River near Morris, Illinois.

Another contract recently awarded Midwestern is from the Great Lakes Pipe Line Company, as follows:

From Hawarden, Iowa, to Sioux Falls, South Dakota, 39 miles of 12-in. This work has begun with the field office at Canton, South Dakota. R. C. Stanley is superintendent and Mac Hoffman assistant superintendent. The contract also includes installing additional yard piping, a truck loading rack, and miscellaneous construction at Mankato, Minnesota, station. Earl S. Powell is the superintendent in charge. This work also has begun. At the Sioux City, Iowa, terminal station an extension is being made to the building and two 800-hp pumping units installed, as well as yard piping, a truck loading rack, and driveway. F. C. Snavely is superintendent. This work is under way.

One section of the Northern Natural Gas Company work is better than half completed. This consists of 43.4 miles of 26-in. between Palmyra, Nebraska, and Oakland, Iowa, station. The field office for this spread is at Atlantic, Iowa, with M. T. Wilhite the superintendent and Denver Franklin assistant superintendent. The 65.9 miles section of 26-in. extending northeastward from Oakland is now under construction. Also for Northern Natural, additions are being made to the compressor stations at Palmyra and Beatrice, Nebraska. Lyle S. DeWitt is superintendent at Palmyra and J. A. Bard at Beatrice.

The job for Southern California Gas Company and Southern Counties Gas Company of California is nearing completion. This is a joint venture with **Johnson Western Gunite Company** and **L. E. Dixon,** and consists of 83 miles of 30-in. near Riverside, California, where the field office is situated.

▸ **J. L. Cox and Son,** Raytown, Missouri, (stringing contractors), are stringing 236 miles of 16, 18, and 24-in. pipe in Mississippi and Alabama for Southern Natural Gas Company. Fred Osterman and Lionel Pugh are foremen. The work was about 20 per cent completed August 16.

▸ **Smith Contracting Corporation,** 205 Northwest Seventh Street, Fort Worth, Texas, has completed Section 10 of the Transcontinental Gas Pipe Line Corporation system and has laid approximately 45 per cent of Section 11. The field offices are at Fredericksburg and Herndon, Virginia. C. C. Craig is spread superintendent and H. J. McAdams office manager at Fredericksburg. At Herndon, Jack Landers is superintendent and M. E. Williams office manager. The two sections represent 196 miles of 30-in., extending from Chatham, Virginia, to the Potomac River.

It is hoped that a start can be made by September 15 on the 108 miles of 16-in. between Baytown and Provident, Texas, for Texas Eastern Transmission. Job is held up awaiting pipe.

▸ **Holland Construction Company,** 906 First National Bank Building, Tulsa, Oklahoma, is laying 20 miles of 22-in. gas line for Washington Gas Light Company.

▸ **R. H. Fulton and Company,** Box 1526, Lubbock, Texas, has completed one of the loops it is laying for Northern Natural Gas Company, a second loop is almost finished, and two more loops are now under construction. A total of 222 miles of 26-in. is being laid in Texas, Oklahoma, and Kansas. In addition, 155 miles of 20-in. is being laid for Northern Natural between Garden City and Bushton, Kansas.

The Transcontinental job, consisting of 204 miles of 30-in. in Virginia and North Carolina, is approximately 90 per cent completed.

For Trunkline Gas Supply Company, work is already under way on 184 miles of 26-in. September will see the start on 278 miles of 20-in. for the same company.

▸ **Canadian Bechtel, Ltd.,** and **Fred Mannix and Company, Ltd.,** Calgary, Alberta, Canada, as a joint venture, are laying 441 miles of 20-in. crude oil line for Interprovincial Pipe Line Company, from Edmonton to Regina. Work is in full progress on three spreads. The project office is at 416 Northern Hardware Building, Edmonton, Alberta. E. W. Davis is project manager and Ralph Hamilton assistant.

▸ **Fish Pipeline Construction Corporation,** M. and M. Building, Houston, Texas, will build the compressor stations on the Texas Illinois Natural Gas Pipeline Company system. Three compressor stations have been approved by the Federal Power Commission and will be constructed beginning this fall. Two others are planned but have not been certified.

Williams Brothers-Davis Company, 6006 Jensen Drive, Houston 16, Texas, is laying 85 miles of 30-in. for Transcontinental Gas Pipe Line Corporation, from El Campo, Texas, to a point north of Humble. H. L. Davis is in charge. The field office is a Humble with Sam Davis the timekeeper.

Anderson Brothers Construction Company, 707 North Drennan Street, Houston, Texas, has contracted to lay 360 miles of pipe on the Trunkline Gas Supply Company system, a part of the work being under way. Section B, on the main line, consists of 180 miles of 26-in. between Darnell, Louisiana, and Senatobia, Mississippi. Sections G and H are laterals consisting of 217 miles of 24-in. from Longville, Louisiana, to Altair, Texas.

For Lakehead Pipe Line Company, the United States portion of Interprovincial, 360 miles of 18-in. are being laid between Gretna, Manitoba, and Superior, Wisconsin.

For Tennessee Gas Transmission Company, 65 miles of 30-in. are being laid between Lancaster and Campbellsville, Kentucky, and 75 miles of 26-in. from Morehead to Fullerton, Kentucky, and between Load and Catlettsburg, Kentucky.

For Transcontinental Gas Pipe Line Corporation, approximately 82 miles of 30-in. are being laid from Eunice, Louisiana, to a point near Deweyville, Texas.

Arabian Bechtel Corporation, 220 Bush Street, San Francisco, California, has been awarded a contract by Iraq Petroleum Company, Ltd., to lay 566 miles of pipe from Kirkuk to Baniyas. The major part of the pipe will be of 30 and 32 in. diam; 90 miles will be 26 in. The first pipe is expected to be laid in October. Clark Rankin, vice president of Bechtel, is project manager.

H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of 373 miles of 26-in. high pressure natural gas pipe line for Tennessee Gas Transmission Company from the north bank of Ohio River, east of Portsmouth, Ohio, and extending northeastward to near Buffalo, New York. Work on the initial section of nearly 220 miles through Ohio was completed as of August 10. Work on 153-mile section through Pennsylvania and New York is now underway and scheduled for completion by mid-fall. Spreads are located as follows:

Sharon, Pennsylvania, Box 302, telephone 20674: G. A. Reutzel, superintendent; W. E. Yount, office manager; J. A. Hairston, right-of-way foreman; L. J. Loncarich, ditch foreman; J. C. Anderson, bending foreman; H. C. Morrison, pipe foreman; K. N. Adkins, pipe foreman; R. W. Orr, welding foreman; S. J. Wood, coating foreman; A. L. Bell, lower-in foreman; T. E. Walker, clean-up foreman.

Dunkirk, New York, Box 177: R. K. Shivel, superintendent; R. E. Burgess, office manager; J. D. White, right-of-way foreman; W. H. Olrich, ditch foreman; J. H. Latham, bending foreman; C. E. Shivel, pipe foreman; R. L. Ezell, welding foreman; U. M. Beaver, lower-in foreman; Sam Price, clean-up foreman; Ray Drewell, crossing foreman.

The company also has the general contract covering construction of approximately 480 miles of main transmission line for Texas Illinois Natural Gas Pipeline Company from near Refugio, Texas, and extending northeastward to the Texas-Arkansas state line. Work began September 1. The contract includes 38 miles of 12-in., 36 miles of 24-in., 97 miles of 26-in., and 309 miles of 30-in. The following two spreads will participate, though no field headquarters have been established:

Spread Three: W. B. Williams, superintendent; P. O. Rutledge, office manager; R. H. Edwards, right-of-way foreman; K. K. Kelly, ditch foreman; Roy Stegall, bending foreman; J. I. Cobb, pipe foreman; C. F. Jones, welding foreman; Rube Owens, coating foreman; A. D. Hamilton, lower-in foreman; Fred Williams, clean-up foreman.

Spread Four: C. R. Ice, superintendent; G. A. Harvey, office manager; John E. Hamilton, right-of-way foreman; E. W. Whisenant, ditch foreman; Forest Loinette, bending foreman; L. O. Reutzel, welding foreman; N. D. Adams, coating foreman; J. C. Rich, lower-in foreman; E. D. Worley, clean-up foreman.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas (stringing contractors), have the following jobs under way:

For El Paso Natural Gas Company, 415 miles of 24-in. between Fruitland, New Mexico, and Yucca, Arizona. This is what is known as the San Juan line.

H. C. Price Company (Tennessee Gas Transmission Company), 400 miles of 26-in. in Ohio, Pennsylvania, and New York.

Conyes Construction Company (Montana-Dakota Utilities Company), 340 miles of 12-in. in Wyoming and Montana.

El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Price-Morrison, Austin, Texas, have a joint venture general contract covering construction of 158 miles of 30-in. high pressure natural gas pipe line for Tennessee Gas Transmission Company in western Tennessee and Kentucky. Contractors: Price Constructors, Inc., Bartlesville, Oklahoma (sponsor), and Morrison Construction Company, Inc., Austin, Texas. Joint venture office: Lockhart Building, 311 East Eleventh Street, Austin, Texas. Work was approximately 60 per cent completed as of August 10. Spreads located as follows:

Linden, Tennessee, General Delivery: Jack Hodges, superintendent; A. G. Goyne, office manager; foremen are: Dick Rash, right-of-way; Red Wright, ditch; Ralph Farrar, pipe; Harry Ebers, welding; Cowoby Tatom, bending; E. E. Wilkerson, lower-in; Willie Sullivan, clean-up; Jack W. Bradfield, crossing; Frank Coleman, bending.

Horse Cave, Kentucky, P. O. Box 236: R. L. McMillon, superintendent; E. J. Price, office manager; W. K. Stowell, right-of-way foreman; John Dyer, ditch foreman; Rex Pickens, pipe foreman; Ab Campbell, welding foreman; Rip Vann, dope foreman; Ray Huston, bending foreman; Leon Pharris, lower-in foreman; G. B. Whitehead, clean-up foreman; J. L. Hodge, double-joint foreman.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, is laying the 340-mile, 16-in. section of Interprovincial Pipe Line Company's system between Regina, Saskatchewan, and Gretna, Manitoba. The system, overall, will extend 1150 miles from Edmonton, Alberta, to Superior, from where the crude oil will be moved by lake tanker to Imperial Oil Ltd.'s refinery at Sarnia, Ontario. B. E. Barnes is general superintendent over the work. The three spreads are under the immediate supervision of "Whitey" Martin, Clyde Gregory, and "Pee Wee" Petty.

Williams Brothers also have contracted 60 miles of 12-in. to be laid near Brookville, Pennsylvania, for United Natural Gas Company.

H. L. Gentry Construction Company, 921 Michigan Avenue, Jackson, Michigan, has contracted to lay a 125-mile, 8-in. products line for Susquehanna Pipe Line Company from Sun Oil Company's refinery at Toledo, Ohio, to Sarnia, Ontario, Canada. Work has begun and the job is scheduled for completion Dec. 1.

For Mid-Valley Pipeline Company, 90 miles of 22-in. are being laid between Mt. Washington and Hebron, Kentucky.

- PIPELINE PERSONALS -

L. C. Messimer has been appointed electrician foreman of the Jal division of El Paso Natural Gas Company, one of eight recent promotions announced by the company. **R. A. Watzke** has been made foreman of the El Paso, Texas, machine shop. **Ray E. Sherman** has been promoted to chief construction accountant. **R. H. Barnett,** formerly Jal field foreman, has been named Jal field superintendent. **Paul R. Beebe** has been made assistant plant superintendent at Jal Plant No. 3, being promoted from chief maintenance mechanic at Keystone field plant. **Pat Heckman,** formerly chief maintenance mechanic at Wasson plant, is now chief operator of the Dimmitt compressor station. **J. C. Yoakum,** formerly chief maintenance mechanic at Jal Plant No. 1, has been promoted to assistant plant superintendent in charge of the Monument plant. **Roy M. Hays** is now the chief operator of the McElroy-Crane plant. Before his promotion he was chief maintenance mechanic at Goldsmith.

S. G. Snyder, after 28 years service with Skelly Oil Company, has retired as superintendent of the pipe line department in Kansas. The expression of his loyalty and work, and the feeling that his co-workers had for him was expressed in the tribute paid him (and to his wife, Mrs. Snyder) at the pipe line department's picnic, held in Wichita, Kansas.

George E. Ault has been promoted from assistant superintendent to the position of superintendent. Ault will be in full and complete charge of the department's equipment, personnel, and operations.

Mark V. White has been promoted to the position of assistant superintendent. White is moving with his family to El Dorado, Kansas, and will work out of the El Dorado office in his new capacity.

J. M. Johnson has been promoted to the position of district foreman of the Cunningham-Burrton-McPherson district, supplanting White.

Corwin H. "Charley" Hinton, formerly of the Amarillo, Texas, office of Panhandle Eastern Pipe Line Company, has been made superintendent of the production and gathering department and transferred to Liberal, Kansas. He replaces **W. K. Sanders,** who is now associated with Trunkline Gas Supply Company.

Stephen A. Bergman has succeeded **Farrile Young** as assistant chief engineer of the company. Young also has been transferred to Trunkline. Bergman was senior engineer in the pipe line department.

Fred Culvern is the new head of compressor station construction, replacing **Norman F. Blundell,** now with Trunkline.

New superintendent of the Eastern Pipe Line Division with headquarters at Maumee is **Henry C. Humphrey,** formerly foreman of District No. 10, Tuscola. He takes the place of **Ben H. Longshore,** now with Trunkline. **J. W. Roberts,** who has been foreman of District No. 31, Delavan, replaces Humphrey. **Ossie W. Steele** will assume duties as foreman of District No. 31 after construction is completed in District No. 7, Mexico, where he is now foreman.

Willard G. Wiegel has been elected treasurer of Lone Star Gas Company, Dallas, to succeed **H. G. Cornatzar,** who has retired under the company's pension-insurance program after more than 33 years' service. Wiegel retains his position as director of personnel, to which he was appointed in 1942, **D. A. Hulcy,** president, said.

Wiegel, a native of Springfield, Ohio, joined Lone Star in 1928 in the capacity of special representative. In 1929 he was assigned to the advertising department as assistant to the director, nd in 1930 was appointed advertising manager. He served in that capacity until his appointment as personnel director in October, 1942.

Cornatzar, the retiring treasurer, joined Lone Star in 1917 as a bookkeeper in the four-member accounting department of the general offices. He became the company's first traveling auditor in 1918, and in 1920 was namer assistant secretary, and two years later was given the additional duties of assistant treasurer. In 1942 he was named treasurer of the company.

Frank Earl Renner, who has been machine shop foreman at Matfield Green station, Kansas, for Cities Service Gas Company, retired effective September 1. Renner was first employed on November 29, 1914, by the Kansas Natural Gas Company at Hogshooter, Oklahoma. He was transferred to Grabham station in 1918 and to Petrolia in 1927. He has been machine shop foreman at Matfield Green station since 1929. He will make his home in Bartlesville, Oklahoma.

E. Clyde McGraw has been made vice president in charge of operations by Transcontinental Gas Pipe Line Corporation. McGraw resigned as vice president of Stone and Webster Service Corporation, as president of Montaup Electric Company, and as vice president of Tampa Electric Company to assume his new duties with the Texas-to-New York natural gas carrier. Since graduating in engineering from the University of Nebraska, McGraw has had a varied and distinguished career in public utility construction and operation.

Elmer R. Thayer has been transferred from Elmont, Kansas, to Thermopolis, Wyoming, as division machinist by the Service Pipe Line Company.

Gerdes W. Rice, who has been assistant superintendent of right-of-way and claims for the Lone Star Gas Company, Dallas, Texas, has been promoted to the position of superintendent. He succeeds **Ralph H. Shaw,** who died recently. Rice has been in the employ of Lone Star since 1930.

Arthur Laughlin, pipe line foreman at Caney, Kansas, for Cities Service Gas Company, resigned recently to accept a position with the Mid-Continent Pipe Line Company. He was succeeded by **F. L. Vogler,** who was transferred from his position as foreman at Grabham. **Donald E. Sandstrum,** foreman at Guymon, Oklahoma, replaced Vogler, and **Brice Bloodgood** was transferred from Wichita, Kansas, to Guymon. **C. G. Tuttle** replaces Bloodgood at Wichita.

Bernard M. Laulhere, 64, former manager of engineering services for the Southern California Gas Company, Los Angeles, succumbed on August 5 following a prolonged illness that had kept him partially incapacitated since 1948. Born in France, Laulhere was brought to California at an early age.

He was employed in 1921 by the Midway Gas Company and worked in various engineering capacities. In 1923 he became superintendent of transmission of the Midway Gas Company. He was active in construction during the development of the highly productive Santa Fe Springs, Signal Hill, and Huntington Beach fields.

Later he returned to engineering work for the Southern California Gas Company as supervising engineer and them as manager of engineering services. He was assigned to the construction of the 1200-mile Texas-California natural gas transmission line in 1946 and 1947. Shortly after its completion he suffered his first illness.

NEWS

Continental Will Build $2,250,000 Research Lab

Continental Oil Company has awarded a contract for construction of a $2,250,000 research laboratory building in Ponca City, Oklahoma, President L. F. McCollum announced. The new building, a three-story structure comprising mainly 6 individual laboratory units and to be connected to Continental's newest office building in Ponca City, will contain almost 40,000 sq ft of floor space, giving the company a total of more than 85,000 sq ft of laboratory space. The company's total laboratory quarters will be equivalent to a 6-story building, one-half block long and 100 ft wide.

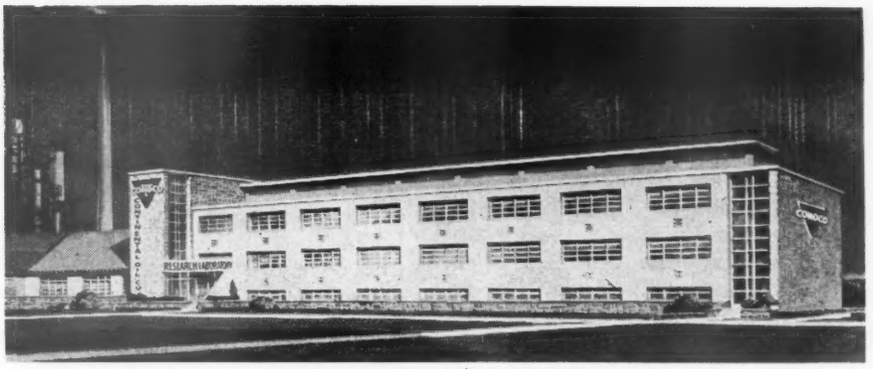
The company's central research laboratories will occupy approximately half of the laboratory space in the new building, which is expected to be completed in fall of 1951. Most of the remaining half of the new laboratory building will be occupied by the laboratory section of the production research division.

Manager of the central research laboratories is E. R. Baker. Other research supervisory personnel includes J. J. Reynolds, supervising production research engineer; W. F. Ford, supervising products-use research engineer; J. A. Murphy, supervising reservoir engineer; H. E. Luntz, supervising the process laboratory; S. J. Bragg, librarian, B. H. Lincoln, patent adviser.

World Output Down in 1949

World production of crude petroleum in 1949 totaled 3,397,691,000 bbl (9,309,000 bbl daily), a decrease of 35.3 million barrels or 1.03 per cent from 1948, a survey made by the Bureau of Mines shows. Principal decline in production was in the U. S. where the daily average declined 478,000 bbl to 5,042,000 bbl daily in 1949. Production in Venezuela also decreased, averaging 1,321,000 bbl daily compared with 1,339,000 bbl in 1948. All other major oil producing countries in the world increased their production over 1948.

Middle East production increased 270,000 bbl in daily average in 1949, but the most notable increase occurred in Kuwait where production almost doubled to average 246,000 bbl daily for the year. Production in Oceania continued to increase, averaging 192,000 bbl daily, compared with 142,000 in 1948. The U.S.S.R., including Sakhalin, is estimated to have increased daily average production 43,000 bbl to 658,000 bbl daily.



Continental Research Laboratory to be built in Ponca City, Oklahoma.

Stress National Security

National security will be stressed by the National Metal Congress and Exposition meeting in Chicago, Illinois October 23-27, the American Society for Metals has reported. Emphasis will be shifted from the economies in production to the more realistic approach of plans, materials, and equipment for high production.

This shift of emphasis will enable some 350 exhibitors and 35,000 registered technical, engineering, and production men to organize and properly integrate their important contributions toward the building of a national security force equal to any, the Society reported.

Committee Named to Report Steel Requirements

Six subcommittees have been named to aid the National Petroleum Council's steel committee to determine the steel requirements of their respective branches. Chairmen of these groups, which are under the direction of Russell Brown, chairman of the Independent Petroleum Association of America, are:

J. Ed Warren, IPAA, domestic production; Frank Porter, API, domestic refining; B. L. Bajewski, Deep Rock, domestic marketing; F. B. Dow, NPA, transportation; N. C. McGowen, United Gas, natural gas transmission; and J. R. Suman, SONJ, foreign operations.

Supports 18 Fellowships

With the recent establishment of new fellowships at the University of Cincinnati and New York University, The Texas Company program now supports 18 fellowships and grants in institutions throughout the country. The Texaco program is designed primarily to provide funds for fundamental research—i.e., research not directed toward the development of products or processes. The fellowship conditions contain no inducement toward future employment.

Crude Oil Prices Rise

The posted price of low gravity crude oil has been increased in California fields for the second time in less than a month. Union Oil Company has posted increases of from 1 cent to 20 cents a barrel on crude of 25-deg gravity and below. Standard Oil Company of California increased heavy fuel oil prices 10 cents a barrel. Standard will generally increase its buying price for 14-deg gravity crude by 10 cents a barrel.

In New York Socony-Vacuum Oil Company raised its prices for home heating oil, kerosene, and diesel oil an average of ½ cent per gallon along the eastern seaboard. Socony's price increase followed similar increase by Atlantic Refining Company and Cities Service. Socony attributed its price increases to higher transportation costs and pointed out that the New York harbor barge price will be the same as in September last year. In Ohio, Standard Oil Company of Ohio advanced prices of all grades of gasoline at all levels throughout the state 0.5 cent a gallon. "This reflects the general increase in gasoline market prices throughout the nation," a company spokesman stated.

Pan-American Production Company has announced a 10c a barrel reduction for crude oil from the Willamar field in Willacy County, South Texas. E. R. Turner, president, said Pan-American had been unable to market the oil at its former price of $2.50 because of undesirable characteristics of the crude.

Build Coal-to-Oil Plant

By next year, the government hopes to have a new plant in operation that will make oil out of coal. To be situated in Louisiana, Missouri, the Interior Department stated that major construction costing $4,915,000 has been completed on the new demonstration plant. Another coal-to-oil plant has been in experimental operation at the Missouri town for more than a year.

NEWS

Industry Spokesmen Say Oil Supplies Are Ample

Since the end of the last war, the petroleum industry has increased its capacity to produce, refine, and transport petroleum products by more than 25 per cent, according to Dr. Robert E. Wilson, chairman of the board, Standard Oil Company (Indiana). It has spent over eight billion dollars on additional facilities. Much of that expenditure came from plowing back a large proportion of its post-war profits. For the immediate future, oil companies can supply all military requirements and meet all needs on the usual scale. There is no need of rationing, even if military demand expands substantially from present levels, is Wilson's opinion.

Another prominent oil man has expressed almost the same opinion as Wilson. Frank M. Porter, president of the American Petroleum Institute, said in an open letter, "The American oil industry is better prepared than ever to meet any national emergency." He pointed out that the nation's capacity to produce and refine petroleum, as well as its proved reserves of underground oil, have increased approximately a fourth since the climax of World War II created peak demands for petroleum products.

August Production Up

Domestic crude oil production may average 5,600,000 bbl daily during August—almost 450,000 bbl more than previous estimates for the third quarter of 1950. This estimate was contained in a report to the Interstate Oil Compact Commission by H. B. Fell, Ardmore, Oklahoma, executive vice president of the Independent Petroleum Association of America.

Fell said this anticipated domestic supply, coupled with imports of 800,000 bbl daily and natural gasoline output of 500,000 bbl, would boost total oil supply to about 6,900,000 bbl a day for the month.

Employees Buy Bonds

Over $760,000 worth of U. S. savings bonds will be purchased by employees of the Stanolind Oil and Gas Company during the next year, according to E. F. Bullard, company president. The three-quarters of a million dollar investment will come as the result of the employees savings and stock bonus plan announced by Stanolind in May of this year. Bullard said that as of July 1, 1950, over 94 per cent of the employees eligible to participate had enrolled in the plan.

NPC Names Group to Study Oil Transportation

The National Petroleum Council has named P. C. Spencer, president of Sinclair Oil Corporation, to head its committee on petroleum industry transportation. Council chairman, Walter S. Hallanan, said the committee will report on the adequacy of the nation's oil tankers, barges, tank cars, tank trucks, and pipe lines.

Others named to the committee are: K. S. Adams, Phillips Petroleum; Munger T. Ball, Sabine Transportation; Lee R. Cowles, Indiana Standard; J. C. Donnell II, Ohio Oil; Fayette B. Dow, National Petroleum and Western Petroleum Refiners Association; B. C. Graves, Union Tank Car; B. I. Graves, Tide Water Associated Oil; Dene B. Hodges, Shell Oil; D. A. Hulcy, Lone Star Gas; Charles S. Jones, Richfield Oil.

Also W. Alton Jones, Cities Service; W. G. Maguire, Panhandle Eastern Pipe Line; Glenn E. Nielson, Husky Refining; S. F. Niness, National Tank Truck Carriers; J. R. Parten, Woodley Petroleum; James P. Patterson, Pan American Petroleum and Transport; T. S. Petersen, California Standard; S. A. Swensrud, Gulf Oil; L. S. Wescoat, Pure Oil; W. S. S. Rodgers, The Texas Company, and A. H. DePriest, Socony-Vacuum.

Danciger Employees Share $1,000,000

Some 400 employees of the Danciger Oil and Refining Company will share in gifts from the company totalling almost $1,000,000. Bulk of the Danciger and J. Farley stock was sold recently to Southern Production Company, Shreveport, Louisiana at a total of $42,000,000. Some of the employees will receive as much as $25,000, Dan Danciger, president, announced.

Texas Oil Men to Meet

The first major gathering of Texas oil and gas producers since the beginning of the Korean war is scheduled in Dallas for October 4-5 when the Texas Mid-Continent Oil and Gas Association holds its 31st annual meeting. Headquarters for the meeting of representatives from all branches of the petroleum industry will be the Adolphus Hotel.

"Since they will be called on for more than 80 per cent of the additional domestic crude oil required for national military security, Texas oil men will use this meeting as a forum for discussion of ways to provide civilian and military petroleum needs," R. B. Anderson of Vernon, association president, announced.

Production Capacity at Highest Volume in History

An Independent Petroleum Association of America report shows that maintenance of oil producing capacity at maximum efficient rates is keyed to continually progressive drilling activity. In a graph analysis in The Independent Monthly, IPAA showed that drilling during the three year period of 1946-48 created 2,200,000 bbl daily of new productive capacity.

The report pointed out that actual production was close to capacity during the three years. New drilling made it possible to increase output by 1,100,000 bbl but, before this could be done, wells had to be drilled to offset a natural decline of about the same amount in older properties. Looking ahead in view of this experience, IPAA said productive capacity at mid-1950 would decline 400,000 to 500,000 bbl daily by June, 1951, if there were no drilling. Thus with U. S. oil requirements increasing steadily, the essential nature of an adequate drilling program is obvious, the report continued.

ECA Claims Overcharges

The Economic Cooperation Administration is seeking a refund on oil sold to China in the amount of $1,135,177, which it stated represented overcharges on refined products financed by the ECA and sent to purchasers in China by the California Texas Oil Company. The ECA holds that there was overpricing on 42 transactions, of which 27 were with The Texas Company (China), a wholly-owned subsidiary of Caltex. The petroleum products were shipped from the Persian Gulf area in 1948 and 1949.

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The Petroleum Engineer

We have had calls for the following back copies of The Petroleum Engineer:

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Vol. 16 Nos. 7 and 13

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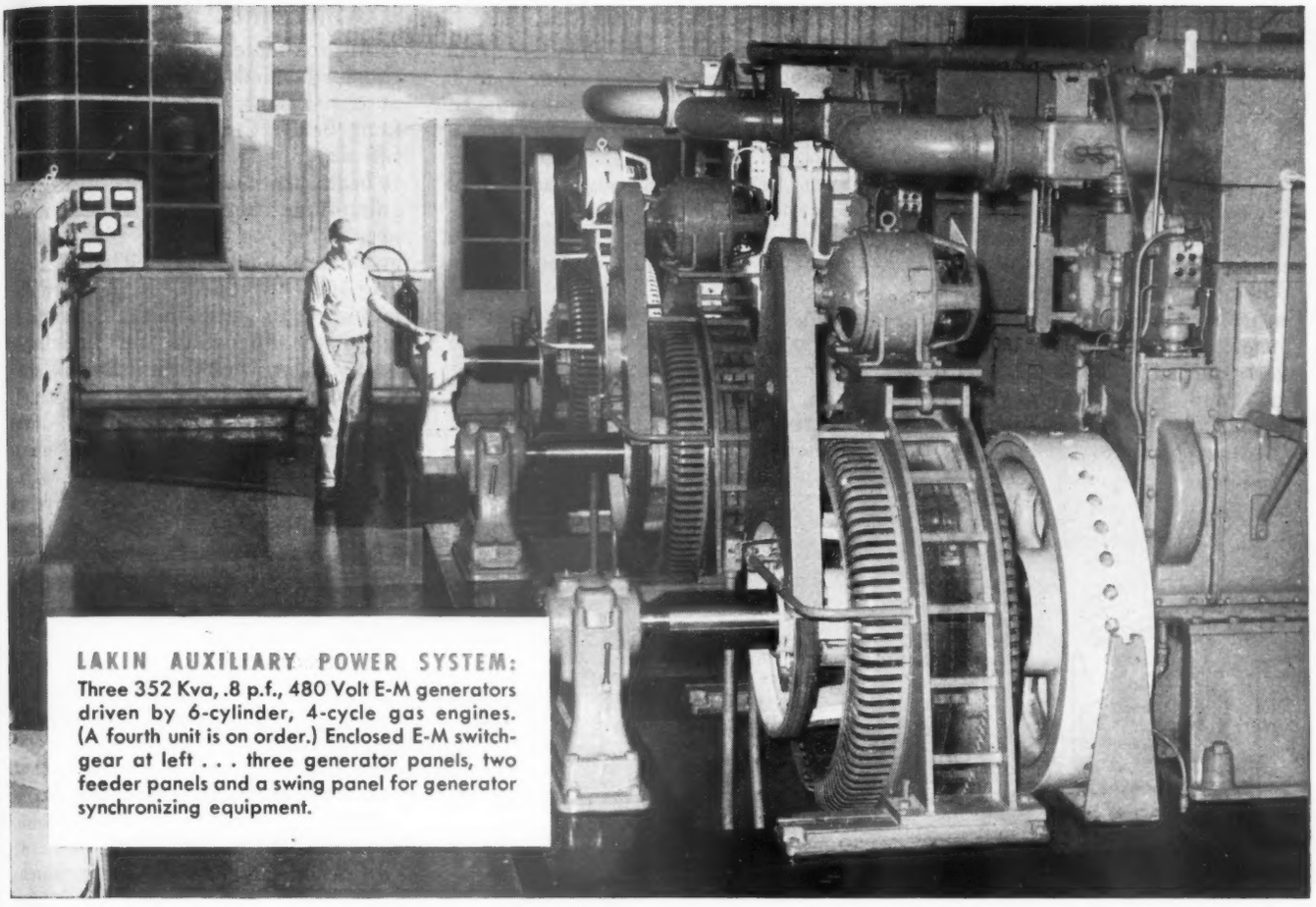

LAKIN AUXILIARY POWER SYSTEM: Three 352 Kva, .8 p.f., 480 Volt E-M generators driven by 6-cylinder, 4-cycle gas engines. (A fourth unit is on order.) Enclosed E-M switchgear at left . . . three generator panels, two feeder panels and a swing panel for generator synchronizing equipment.

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Suppose it happened at 3 A.M. In the sudden, engulfing blackout, the capacity of your pipeline system would be seriously curtailed. Silence at the cooling tower pumps. Air compressors dead. Dangerous heat beginning to mount . . . and the indicating instruments hidden in the dark. However . . . it can't happen here!

The men who designed and built this ultra-modern compressor station at Lakin, Kansas for Colorado Interstate Gas Company were more than usually aware of such hazards—for this is a large, costly and vitally important installation. So they made doubly sure of safety. First, by devising excellent emergency shutdown systems. Second, by specifying E-M generators and switchgear for the auxiliary power system.

Everywhere in the oil and gas industries, engineers know the need for *dependability* in motors, generators and switchgear. There is great significance, therefore, in the fact that many hundreds of E-M installations are now in use at every stage of drilling, pumping, refining and transporting petroleum products.

E-M offers specialized units, backed by the services of specialist field men. Gas-driven generator sets, for example, provide an ideal source of power beyond the power lines. These can be used to start large motors; they have good paralleling ability, and minimum telephone interference. For further information on these and other units, call your nearest E-M office or write to the address below, and ask for publications 1079 and 194.

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SPECIALISTS IN GENERATOR AND SWITCHGEAR ENGINEERING

NIAA Elects New Officers

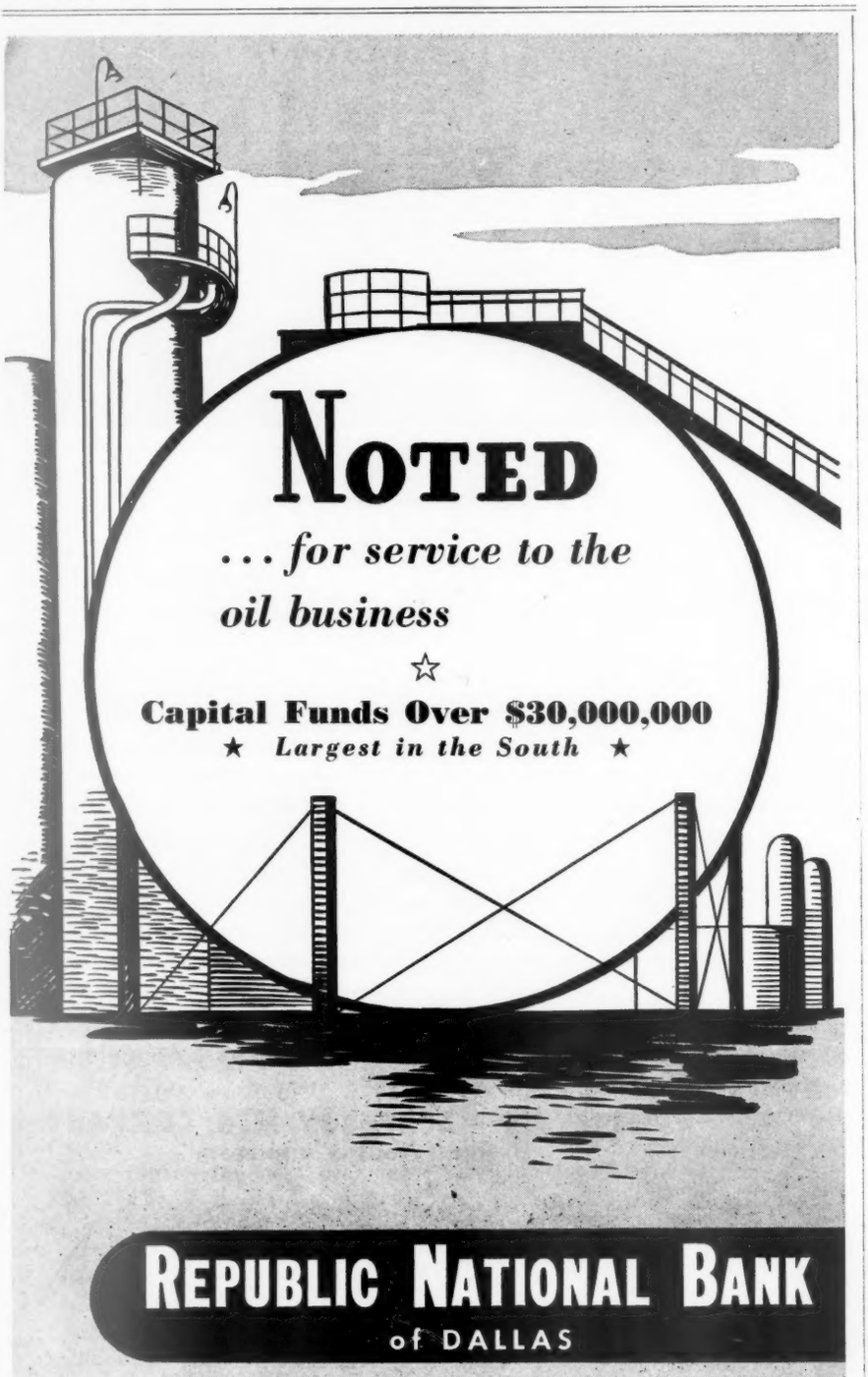
The panel of national officers of the National Industrial Advertisers Association includes a member from the oil field equipment suppliers' ranks. Edward E. Beauchamp, Lane-Wells' advertising engineer, was elected a national vice president of NIAA at that organization's national convention held recently in Los Angeles.

Other officers are Bennett S. Chapple, U. S. Steel, president; Charles W. Shugert, Shell Oil, secretary-treasurer; H. James Christy, Rochester, New York, and James Totten, Toronto, Canada, vice presidents, and Robert A. Joyce, Youngstown, Ohio.

Iraq Royalties Increased

Iraq has increased royalties from foreign oil concessions from 4 to 6 gold shillings per ton on oil removed from the country, a government communique stated. The increased royalties are expected to bring Iraq at least $47,600,000 additional revenue between January 1950 and October 1954, the remaining period during which the old rate was to have remained in effect.

The communique said Iraq will sue Iraq Petroleum Company to determine whether royalties shall be paid in free market gold or at the official exchange rate.



L. A. Nomads Vie for Prizes

Approximately 300 Los Angeles chapter Nomads and friends gathered at the Lakewood Country Club in Long Beach, California recently for a full day of diversion and relaxation. It began in the early morning with a golf tournament, organized and engineered by Joe Schlarb, Bill Wilson, and George Gudenkunst. There was an excellent entry and when the dust was permitted to settle in the late afternoon, the following were declared winners: 1st, Dick Regan; 2nd, Waldo Williams; 3rd, Joe Bergeron; 4th, J. H. Cooke; 5th, Bill Barbee; 6th, Dewey Mong; and 7th, Andy Anderson.

Among the current and ex-foreign delegates noted were, Arnett Norcott, retired manager, International Petroleum, Peru, formerly with Tropical Oil in Colombia; Dutch Slaughter, drilling superintendent for Tropical, and formerly with IPC; Lionel Wiedey, current manager of Tropical in Bogota; Bob Block, ex-Tropical Oiler, and drilling superintendent for IPC when he was retired a few years ago; Walter Little, retired drilling superintendent of Tropical; Lee Chisholm, once assistant to Bob Block in Peru; Ed Coenen, Standard Vacuum, Sumatra; Shorty Bowen, Shell, Colombia; Slim Tidwell, head driller for Iraq Petroleum Co.; Tom Murray, retired International Oiler; and W. N. Thompson, tool pusher for Texas in Colombia.

Distribute 16 Fellowships

Sixteen graduate fellowships with a total value of $23,000 will be distributed among 11 American universities by Standard Oil Company of California for the academic year 1950-51. Each carries a stipend of $1250. plus tuition. Tuition will be paid for fellows studying under the GI Bill in any amount above $500 provided by the government.

Provides For Draftees

The Magnolia Petroleum Company's plan for employees in military training and service in effect for the past 2 years has been liberalized and made applicable to all employees who enter the armed forces. Under the plan, qualified regular employees who enter military service after having been with Magnolia for 6 months receive from the company full regular pay less governmental pay, and allowances for the first 30 days after entering military service. Thereafter, the plan provides for payment to such persons with dependents, one-half of the regular pay less governmental pay and allowances for the rest of the time.

First Half Income About Same as 1949

Net incomes of most of the major oil companies for the first six months of this year showed a slight increase over earnings for a like period of 1949. Some companies, however, are running slightly under that earned in the first half of 1949, while incomes were up from the first quarter report this year for several companies.

Sinclair Oil Corporation has reported $311,086,381 as its gross operating income for the first six months of this year. This compares with a total sum of $29,270,068 for a like period in 1949. P. C. Spencer, president, pointed out that second quarter earnings in 1950 were more than 8 per cent above the same quarter last year. Net profit for Phillips Petroleum Company at the end of the first half of the year totaled $22,039,857, up from the $21,953,129 reported for the first half last year. After taxes had been taken out, Lion Oil Company's net income on June 30, 1950 amounted to $7,147,607.29. Net income for the first 6 months of 1949 amounted to $4,693,599.64. Shell Oil Company has announced a net income of $39,478,935 as against $37,541,531 at the end of the first half of 1949. The Ohio Oil Company has declared a net profit of $17,541,017 for the six months ending June 30, 1950 compared with $17,512,007 reported last year for the same period. Middle States Petroleum Corporation has reported estimated consolidated net income for the first six months of $1,834,100 compared with net estimated income of $1,788,800 for the same period in 1949.

Texas Pacific Coal and Oil Company's net income for the first half of 1950 was estimated at $2,732,341 down from $3,129,976 reported last year. Continental Oil Company and subsidiary companies have declared a net income of $17,103,873 as compared with $20,364,637 reported for the same period last year. Socony-Vacuum Oil Company, Inc. estimated its first six months of 1950 net income at $45,000,000 compared with $47,000,000 for the same time in 1949. Other companies reporting lowered first six months reports are Skelly Oil Company, $11,674,227 down from $13,856,208 last year; Gulf Oil Corporation and subsidiary companies, $50,621,000 down from $51,442,000; Standard Oil Company of California, $35,483,006 during the first half of 1950, below 1949's $38,398,382; Cities Service Company and subsidiaries, $27,577,275 compared with $30,159,009 for the same period last year; Richfield Oil reported $8,478,428, down from $10,201,639.

GREER ACCUMULATOR
Reduces Pump Pulsations 53 to 67%

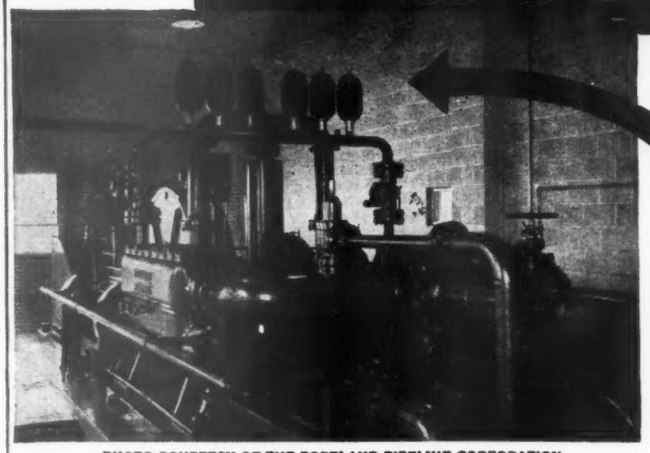


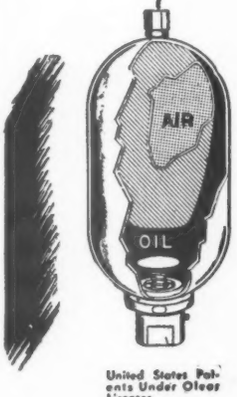
PHOTO COURTESY OF THE PORTLAND PIPELINE CORPORATION
335 FOREST AVENUE, PORTLAND 3, MAINE

PRESSURE surges caused by the pulsating action of piston pumps are the most common causes of pipe line and hydraulic system failures. Oil men in all phases of the petroleum industry have been cognizant of the hazards of pump pulsations but have had to live with that which was considered a necessary evil. This, however, is no longer true because an inexpensive GREER Accumulator installed in the discharge line of the pump will greatly minimize pressure surges by absorbing pump pulsations.

Actual tests on a series of ten pumps were recently conducted at the Portland Pipeline Corporation. A Hydrauliscope and camera attachment were used to measure and photograph the pressure surges before and after the installation of GREER Accumulators. The amazing results showed that the accumulators reduced these surges by 53% to 67%.

Our Engineering Department will be happy to demonstrate by similar tests in your own system the effectiveness of GREER Accumulators. Write for additional details using your company letterhead.

Our Bulletin 500 gives complete details on the elimination of pump pulsations. Write for your copy today.



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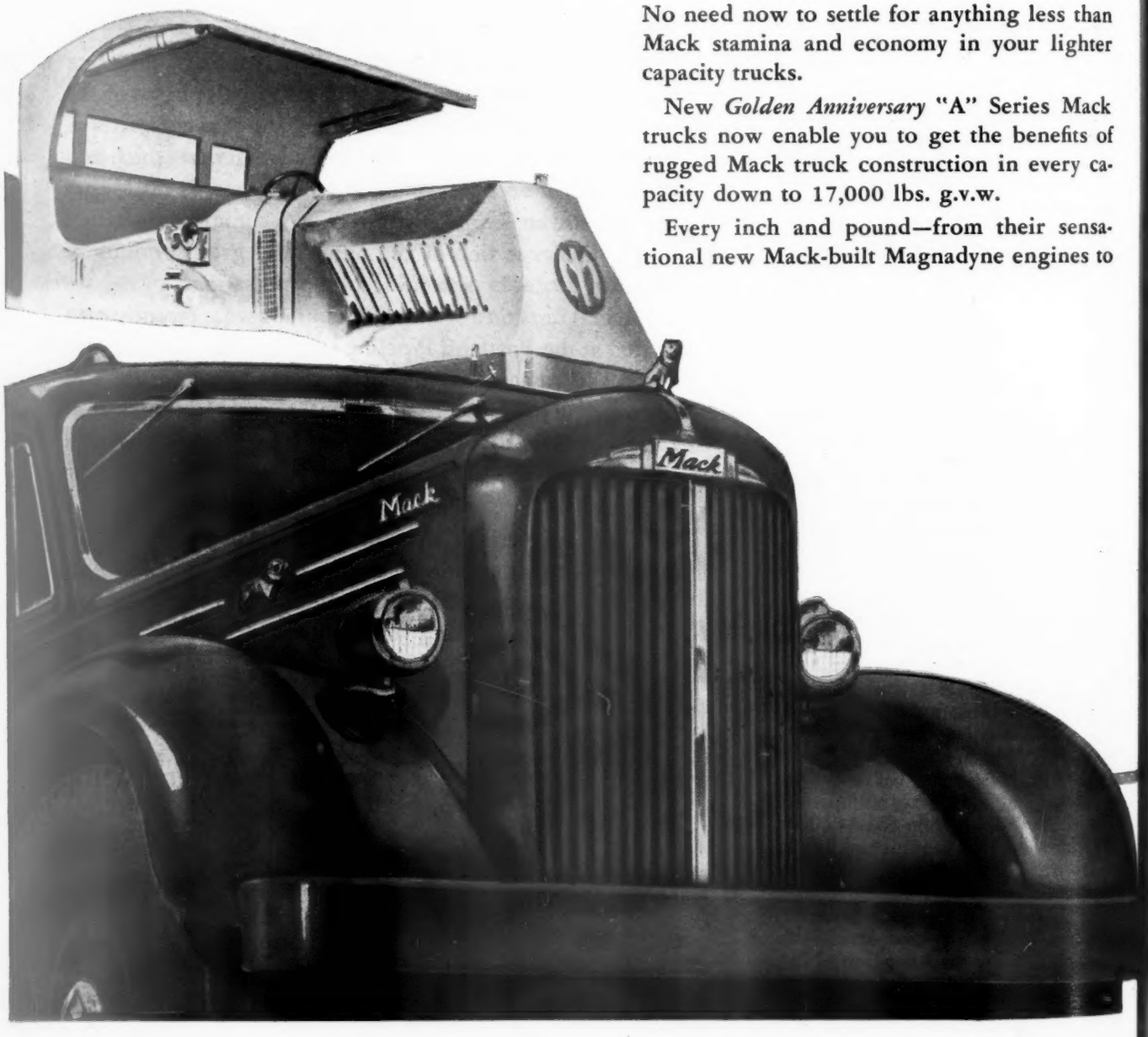
454 EIGHTEENTH ST., BROOKLYN 15, N. Y.

NEW *Golden Anniversary*

Now! Money-Saving Mack before available in Popular



No need now to settle for anything less than Mack stamina and economy in your lighter capacity trucks.

New *Golden Anniversary* "A" Series Mack trucks now enable you to get the benefits of rugged Mack truck construction in every capacity down to 17,000 lbs. g.v.w.

Every inch and pound—from their sensational new Mack-built Magnadyne engines to

MACK TRUCKS

advantages never -Size trucks

their exclusive rubber Shock Insulated spring suspension—these new Macks are engineered in the same high quality Mack tradition as their famous forebears . . . built to handle their hauling jobs with all the enduring reliability and longer life which has marked Mack performance for half a century.

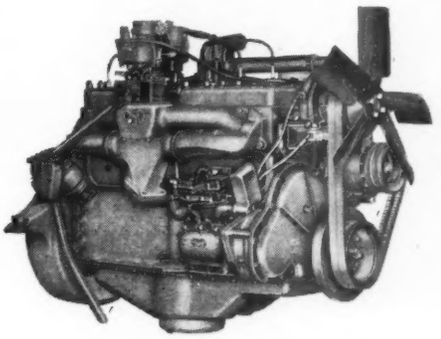
See these great new Macks at your nearest Mack branch or distributor. You'll find that for your lighter hauling jobs, they measure up in every respect to the standards you've grown to expect from dependable, long-wearing heavy-duty Macks.

BE PROFIT-WISE

modernize with

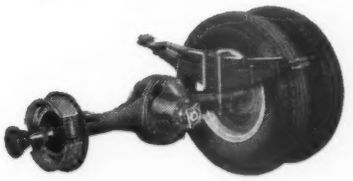
outlast them all

Mack Trucks, Inc., Empire State Bldg., New York 1, N.Y. Factories at Allentown, Pa.; Plainfield, N.J.; Long Island City, N.Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.



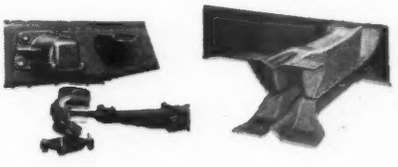
Greater fuel economy . . . longer engine life . . . lower maintenance costs . . . sustained high performance. You get them all in the great new Magnadyne engine—a powerplant designed and built by Mack especially for modern hauling.

Prolonged Clutch Life with less need for adjustment in frequent-stop operations is assured by oversized clutches—one full size larger than customary on competitive makes of trucks.



Broad adaptability to diversified operating conditions is made possible by models which offer a choice of over-geared or direct drive type transmission, as well as axle selection and a range of gear ratios.

Frame stiffness and strength are assured by full-depth side-members braced by cross-members of Mack's box-girder design. Mack rubber Shock Insulators at spring-ends eliminate twisting strain, absorb vibration, require no lubrication or adjustment, last indefinitely.



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G. G. Oberfell

Personals

▸ **G. G. Oberfell,** vice president of research and development for Phillips Petroleum Company, has retired after nearly 26 years of service with the company. A nationally recognized authority on petroleum research, Oberfell established the research and development department for Phillips after joining the company in 1925. In addition to being a vice president of Phillips Petroleum Company, Oberfell is also a director and member of the executive committee of the company, a vice president and director of Phillips Chemical Company, and a vice president of Phillips Terminal Company, the latter two being wholly-owned subsidiaries of Phillips Petroleum Company.

He received his bachelor degree, cum laude, from Miami University, Oxford, Ohio, and is a member of Phi Beta Kappa, honorary fraternity. He later studied at the University of Chicago and University of Pittsburgh and in 1947 was awarded the honorary degree of doctor of science by the University of Tulsa. Early in his career Oberfell was a Bureau of Mines chemist.

▸ **Harry T. Earl,** vice president of Tide Water Associated Oil Company, died August 10 at the Peralta Hospital in Oakland, California, after a brief illness. A resident of Oakland, Earl had been in the service of Tide Water Associated Oil Company for more than 46 years, and was well known in the oil industry generally. He started as a clerk in the company's accounting department, and was appointed a vice president in 1949.

▸ **H. C. Smith** has been elected a member of the board of directors of Pan American Petroleum and Transport Company and a member of the Executive Committees of American Oil Company, Lord Baltimore Filling Stations, Inc., and Mexican Petroleum Corporation, subsidiary marketing companies of Pan American Petroleum and Transport Company. **R. M. Nash** was elected to the boards of directors of these marketing subsidiaries. Smith and Nash assumed their duties on resignation of **C. H. Wagner** from these companies.

Smith has been president of American Oil Company since 1949. He has been associated with Pan American Petroleum and Transport Company and its marketing affiliates since 1927. He is a graduate of the University of Michigan. Nash is general counsel of Pan American Petroleum and Transport, and a member of the boards of directors of Pan American Refining Corporation, Pan American Gas Company, and Mexican Petroleum Corporation of Georgia. He was graduated from Ohio Wesleyan, received his LL.B. from the University of Cincinnati and his LL.M. from the University of Michigan.

▸ **Calvin O. Williams,** linguist and foreign relations specialist, was appointed executive secretary of Southwest Research Institute's International Division. Williams, previously a staff member of Southwest's affiliated Institute of Inventive Research, studied political history and languages at a number of schools including the National University of Mexico in Mexico City and St. John's University in Shanghai, China.

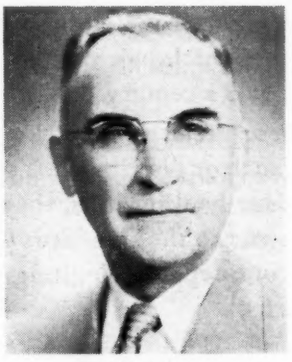
▸ **James W. Templeton** has been promoted to general auditor of The Texas Company succeeding **B. E. Emerson,** who is retiring after 43 years service with the company. **C. N. Ferguson,** special auditor, has been advanced to assistant general auditor. Templeton attended Southern Methodist University and was graduated from the University of Texas. He joined the company 28 years ago. Ferguson began his oil career with The Indian Refining Company in 1917. The company later merged with Texaco, and in 1941 Ferguson was made a special auditor.

▸ **L. S. Wescoat,** president of Pure Oil Company, has been named to the special committee on storage capacity. The committee is set up and sponsored by the National Petroleum Council.

▸ **E. W. Thiele** and **E. W. Adams,** Standard Oil Company (Indiana), were made associate directors of research, and eight others were named

E. W. Thiele

to the newly created position of division director. The title of assistant director of research was abolished. Dr. Thiele received his undergraduate training at Loyola (Chicago) and the University of Illinois, and his Sc.D. degree from Massachusetts Institute of Technology. He joined Standard's research staff in the same year, and became assistant director of research in



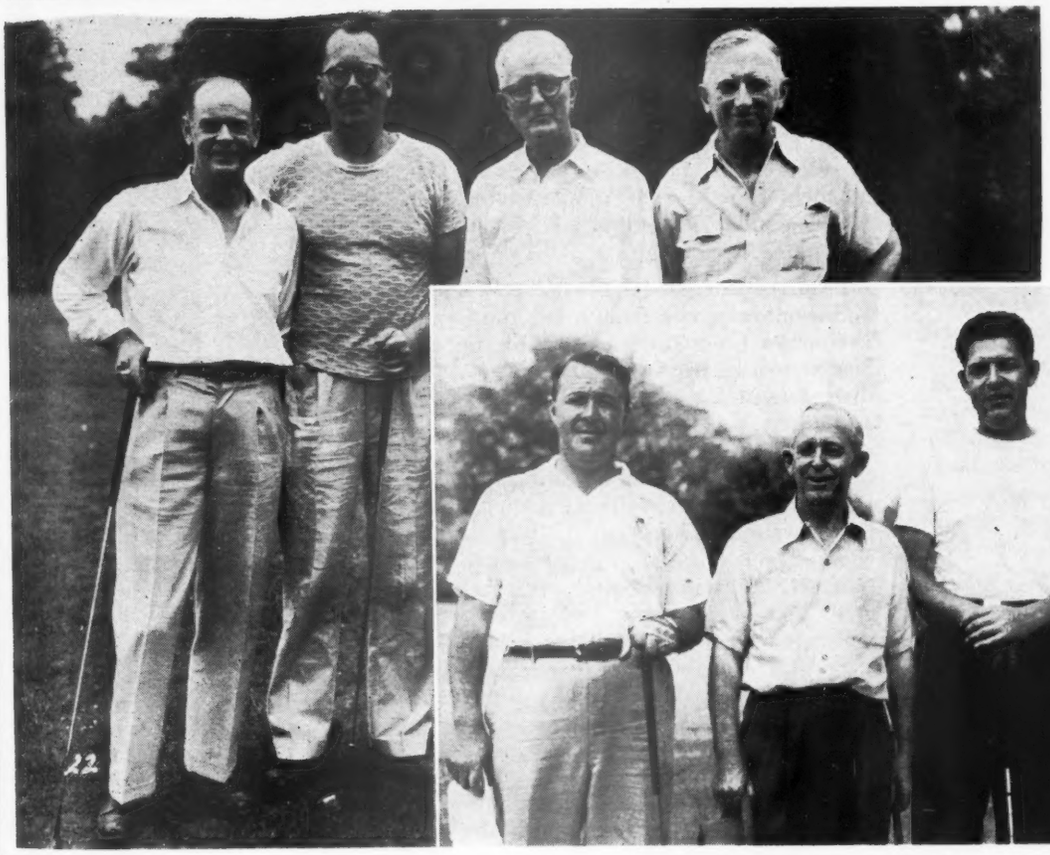
E. W. Adams

1935. Dr. Adams, a graduate of the Universities of Illinois and Wisconsin, joined Standard the following year and became assistant director of research in 1945.

The eight division directors and their fields of activity are: **A. L. Conn,** pilot plants; **J. B. Duckworth,** automotive research; **Nathan Fragen,** all research activities in the field of chemical products; **C. M. Loane,** research on lubricants; **J. E. Seebold,** process design and economics; **B. H. Shoemaker,** exploratory studies in connection with the company's major products; **E. B. Tucker,** analytical research, and **P. C. White,** research on fuels and special products. **R. C. Mallatt** was made chief chemist of the Whiting refinery. Newly appointed section leaders are **H. R. Taliaferro, L. W. Mixon,** and **W. R. Hertwig.** New group leaders are **R. W. Watson, C. W. Brackin,** and **R. L. Yahnke.**

N. Y. Nomads Have Golf Party

T. N. Shultz, right, accepts the Frank Brown Golf Trophy from H. J. McAdams.

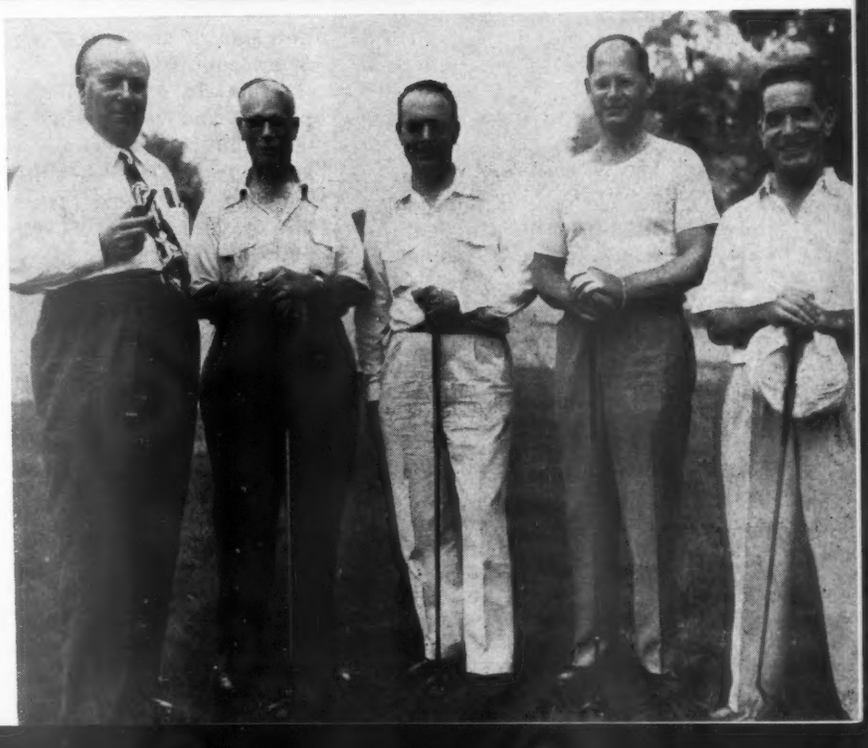


Three foursomes and a fivesome at the New York Nomads annual golf party. Top foursome: M. C. Pollock, The Cooper-Bessemer Corporation; J. A. Clark, Standard Oil Company (N. J.); E. W. (Jack) Berlin, Standard Vacuum Oil Company; J. W. Reed, The Cooper-Bessemer Corporation.

Second foursome: J. B. Roberts, Jr., Chain Belt Company; S. J. Veenstra, Asiatic Petroleum Corporation; J. C. Merwin, Chain Belt; T. G. Schad, Asiatic Petroleum.

Third foursome: J. E. Anderson, Anglo Iranian Oil Company, Ltd.; A. Harvey, Cardwell Manufacturing Company; W. H. Busold, Bill Foster Associates, Inc.; E. F. Gahan, E. F. Gahan Inc.

At right: R. J. Eiche, R. J. Eiche & Associates, Inc.; Byron M. Landis, Web Wilson Oil Tools, Inc.; R. W. Sexton, Jr., Eiche & Associates; Herb E. Maland, Eiche & Associates; Jack Russell, Trinidad Leaseholds, Ltd., Trinidad.



▸ **B. F. Stradley,** formerly secretary and treasurer of Phillips Petroleum Company, was elected a member of the board and of the executive committee

B. F. Stradley

and was named vice president and treasurer, recently. A graduate of the University of Missouri, Stradley began work with Phillips in 1924 as a clerk in the oil accounting section. He was elected assistant secretary-treasurer in 1932. **R. W. Thomas,** manager of the research and development department, was elected vice president of research and development and will supervise research and patent activities, as well as chemical manufacturing, development, and sales. He began in the engineering department in 1926. **Paul J. Parker,** assistant secretary and assistant treasurer, was elected secretary and assistant treasurer. He entered company employment in 1936 as a staff attorney in the legal department and moved into the treasury department in 1945.

▸ **John W. Bisbing,** member of the research staff, petroleum-engineering department, Pennsylvania State College, has joined the faculty of Texas Technological College, Lubbock, Texas. He will serve on the petroleum-engineering staff as an assistant professor, specializing in reservoir-engineering and reservoir-mechanics courses.

▸ **Thomas G. Rabbitt** was appointed assistant general traffic manager of Sun Oil Company. He had served as superintendent of tank car equipment since 1943. **Richard C. Harvey** and **Lee A. Christiansen** were named as assistant traffic managers. Harvey formerly was office manager for Sun's traffic department, while Christiansen had been on loan to the Mid-Valley Pipeline Company as traffic manager for the past year.

▸ **Max L. Krueger,** independent consulting petroleum geologist, has announced his candidacy on the Republican ticket for representative in the Wyoming State Legislature.

▸ **W. L. Forster,** general manager of the Royal Dutch-Shell group in Venezuela, has resigned his position effective October 31, 1950. Forster has been with Shell for the last 25 years, 3½ of which were spent as manager in Venezuela. **R. C. McCurdy,** general manager for the western division of Shell Caribbean in Maracaibo, will succeed Forster. The former assistant to the general manager in Caracas and recently in Maracaibo, **W. L. G. Starrenburg,** will succeed McCurdy.

▸ **Kenneth A. Danskin** has joined the Lubrizol Corporation of Cleveland, Ohio as technical assistant to the vice president in charge of manufacturing, the company announced. Danskin has been staff member of The Texas Company's technical and research division in New York since 1944. He was associated with The Texas Company for 18 years, serving in research and production capacities at their refineries at Lawrenceville, Illinois and Port Arthur, Texas before going to New York.

▸ **Frank Phillips,** honorary director and honorary chairman of Phillips Petroleum Company and one of the best known figures in the oil industry, died August 23 at a hospital in Atlantic City at the age of 76 years. His death followed an operation.

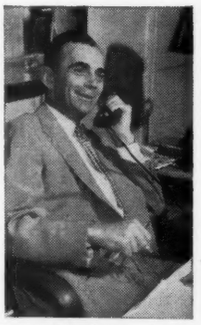
He and his brother, the late L. E. Phillips, organized Phillips Petroleum Company in 1917 and for the first 21 years Frank Phillips was president. After K. S. Adams became president at Phillips' suggestion in 1938, the latter served as chairman of the board.

Phillips was born at Scotia, Nebraska, in 1873. When the oil was discovered at Bartlesville, Indian Territory, in 1903 he went there and organized a bank of which he was president. He branched out into the oil business and his interest grew until the establishment of the Phillips company, now one of the largest oil companies of the country.

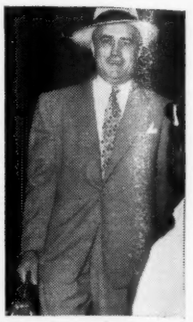
From an organization of 27 employees and assets listed at $3,000,000, Phillips Petroleum Company has grown to become a leading U. S. oil company with more than 17,000 employees and assets of approximately $625,000,000.

Frank Phillips had a wide interest in education and in charitable works. His appointments and honorary memberships and degrees are legion. He was admitted to the Oklahoma Hall of Fame in 1939, was awarded the distinguished service citation by the University of Oklahoma in 1949 and the French decoration of Chevalier of Legion of Honor in 1928. He received many high honors for his fine work among the Boy Scouts of America.

These men are working for you



Energetic, keen-minded JOHN G. SEILER, Tube Turns' Executive Vice-President and General Sales Manager, keeps a sensitive finger on the pulse of your piping needs.



Solid, wiry JOHN W. GREEN, Sales Manager of Tube Turns' Fittings Division, arrives in New York for confab with Eastern representatives.

Rangy, quick-smiling THOMAS H. PIKE, Jr., Assistant Sales Manager of Tube Turns' Fittings Division, awaits flight call for personal check on West Coast piping picture.

JOHN E. CHUMBLEY, slender, youngish Sales Manager of Tube Turns' Forgings Division, makes frequent field trips that pay off in better products, faster service.

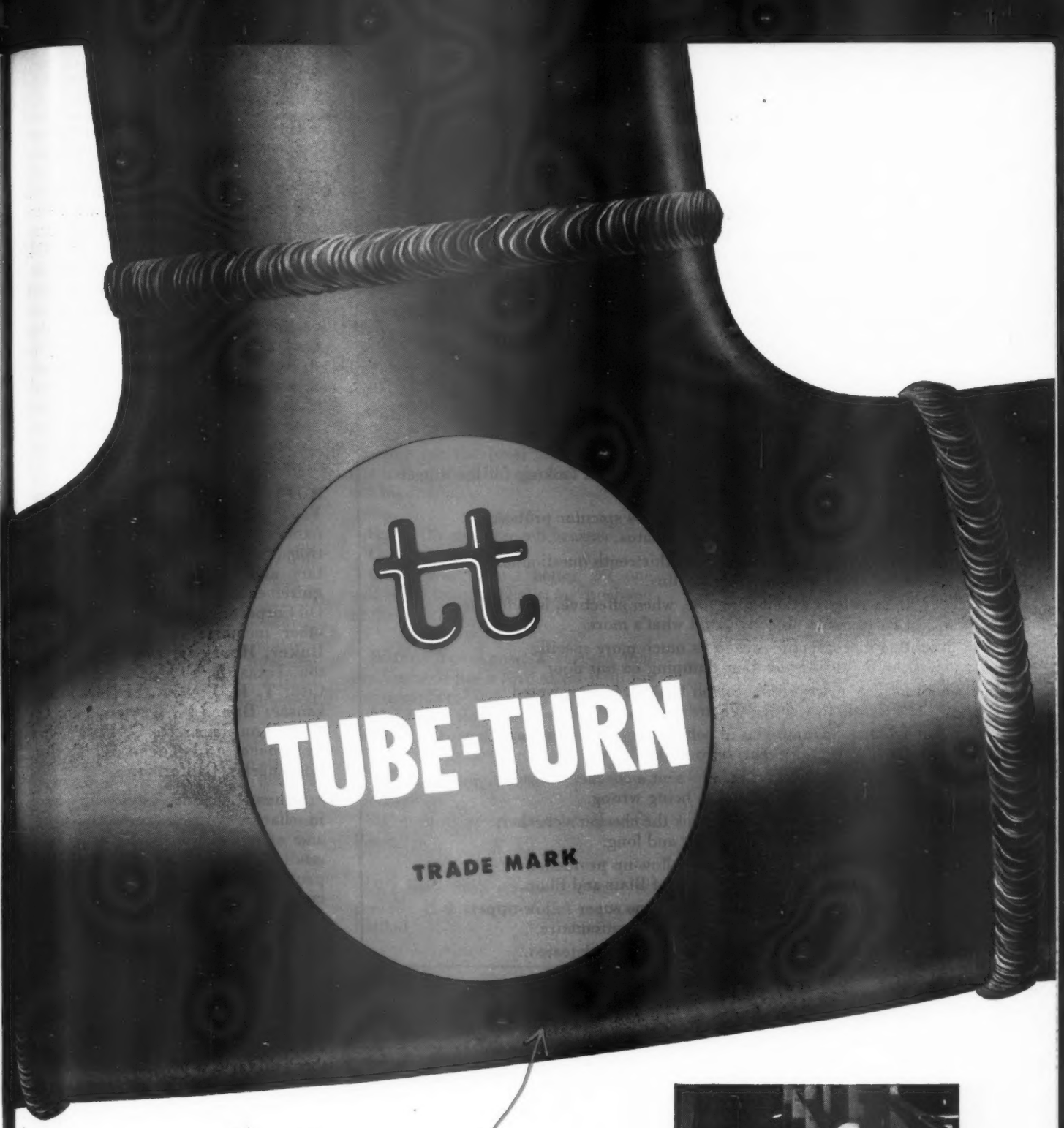
MOST travel-minded group of American businessmen today are sales executives. Covering millions of air, rail, and highway miles each year, these modern Marco Polos have chucked the Ivory Tower attitude of their predecessors.

Like many another sales management team, John Seiler, Jack Green, Tom Pike and John Chumbley look upon service as the father of sales. "Our customers are smart," confides Seiler. "They don't just *buy,* they *discriminate!* Field trips are the best way I know to find out how we can serve them better. It takes plenty of leg work in this business. Your customer can usually give you some pretty solid ideas on product improvement. We've prospered because we listen to what he says . . . *in person!*"

Some 2200 distributor salesmen, the sales-engineering staffs of Tube Turns' 8 district offices, and the finest group of piping technicians in the industry, follow this customer-service policy to the letter. Results: Tube-Turn welding fittings and flanges are the best in the company's history; Tube Turns' customers get qualified help in utilizing its products more and more profitably.

"Be Sure You See The Double tt"

TUBE TURNS, INC.
LOUISVILLE 1, KENTUCKY



In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY DISTRIBUTORS IN ALL PRINCIPAL CITIES

DISTRICT OFFICES: NEW YORK • PHILADELPHIA • PITTSBURGH • CHICAGO • HOUSTON • TULSA • SAN FRANCISCO • LOS ANGELES

In Canada... Tube Turns of Canada Limited, Chatham, Ontario

ODE TO RED TAPE

or

HERE WE GO AGAIN

As Head of the Division for Revision of Provision
Was a man of prompt decision;—Morton Quirk.
PhD in Pathogenics; PDQ in Calisthenics,
He had just the proper background for the work.
From the pastoral aroma of Aloma, Oklahoma,
With a pittance of a salary in hand,
His acceptance had been whetted, even aided and abetted
By emoluments that netted some five grand.
So, with energy extatic this fanatic left his attic,
And hurried on to Washington, D. C.
Where, with verve and vim and vigor, he went looking for the nigger
In the woodpile of the WPB.
After months of patient process, Morton's spicular proboscis
Had unearthed a reprehensible hiatus.
In reply from Blair and Blair to his thirteenth questionnaire,
In regard to their inventory status,
They had written: "Your directive, when effective, is defective
In its ultimate objective, and what's more
"Neolithic hieroglyphics are to us much more specific
Than the drivel you keep dumping on our door".
This sacrilege discovered, Morton fainted, but recovered
Sufficiently to write: "We are convinced
"That sabotage is camouflaged behind perverted persiflage,
Expect us on the twenty-second inst".
But first he sent a checker, then he sent a checker's checker,
Yet nothing was disclosed as being wrong,
So a checker's checker went to check the checker's checker,
And the process was laborious and long.
Then followed a procession of the follow-up profession
Through the records of the firm of Blair and Blair,
And from morning until supper some new super follow-upper
Tore his hair because of Morton's questionnaire.
The file is closed, completed, and our hero, undefeated,
Carries on in some department as before.
And victory is in sight of, not because of, but in spite of
Doctor Morton's mighty effort in the war.

▸ **R. F. Baker,** vice president in charge of domestic producing operations, and **A. C. Long,** vice president in charge of foreign operations (Eastern Hemisphere), The Texas Company, were elected directors of the company. **J. S. Leach,** vice president in Houston, was elected executive vice president with headquarters in New York. He continues as a director. **G. R. Bryant,** general manager of the refining department, was elected vice president with headquarters in Houston, succeeding Leach. **J. T. Wood, Jr.,** assistant to the president, was elected vice president in charge of foreign operations (Western Hemisphere). **C. E. Olmsted** has resigned as director and vice president of the company. He is planning retirement October 1.

▸ **Rush Greenslade,** vice president of the Gulf Oil Corporation and in charge of its Tulsa production and pipe line division, has retired from active service. He has been associated with Gulf in an executive capacity for more than 30 of his 36 years of service and will be succeeded by **P. H. Bohart.** A graduate of Ohio State University, Greenslade's experience in the oil industry all has been with Gulf and its subsidiary companies and dates back to 1914 when he joined the law department of the Gypsy Oil Company at Tulsa. He was elected vice president of the Gulf Oil Corporation and the Gulf Refining Company in 1935, and also has served as a vice president of the Gulf Research and Development Company and the Canadian Gulf Oil Company.

▸ **Roy S. Reed** has been named employe relations supervisor for Stanolind Oil and Gas Company. Formerly labor relations supervisor, he will fill the position vacated by the recent death of **Homer L. Chapman.** Originally joining the company in 1934, Reed worked for the producing department in field operations. In 1944 he joined the industrial relations department as a senior clerk. Since that time he has served as a training instructor, division industrial relations supervisor at Stanolind's Fort Worth office, and labor relations supervisor in the company's Tulsa general office. He attended the Universities of Wyoming, Tulsa, and Oklahoma.

▸ **B. Brewster Jennings,** Socony-Vacuum Oil Company, has been named chairman of the National Petroleum Council's committee on military and government petroleum requirements. **J. Frank Drake,** Gulf Oil Corporation, is vice chairman, and other members include: **Hines H. Baker, Harry Leyendecker,** Houston, Texas; **L. F. McCollum,** Ponca City; **T. H. Barton,** El Dorado, Arkansas; **Bruce K. Brown,** New Orleans, Louisiana; **R. G. Follis,** San Francisco, and **Reese H. Taylor,** Los Angeles, California.

▸ **James R. January** has been placed in charge of joint-ownership plants and other joint-ownership gas interests of Magnolia Petroleum Company's natural gas department. This creates a new departmental assignment within the natural gas department.

▸ **Charles H. Jones** has been named assistant traffic manager The Texas Company with headquarters in New York. Jones joined the company in 1929 as a rate clerk, progressing through various positions in the railway traffic and sales department until he was made assistant to traffic manager in 1946, a position he held until his recent appointment.

▸ **James Tanham,** vice president of The Texas Company in charge of industrial and public relations, has retired. He joined the company after release from Naval service at the end of World War I. Before being elected vice president in 1941, he had been for almost 8 years assistant to the president, and prior to that time for a number of years had been assistant to the vice president in charge of sales.

Tanham is chairman of the board of the National Safety Council, a member of the board of directors of the Chamber of Commerce of the United States, and a member of the Executive Committee of the Chamber of Commerce of the State of New York.

UNIVERSITY OF MICHIGAN LIBRARIES

LAUGH WITH BARNEY

Bride: (reading an oddity): "It says here that in India a man doesn't know his wife until they are married."

Groom: "That ain't the only country."

"You've read the quotation wrong, Miss Adams," said the professor. " 'All men are created equal,' is the quotation, not, 'All men are made the same way'."

Employer to beautiful blonde who has just filled in job application: "Miss Jones, under 'Experience' try to be a little more specific than just 'Oh Boy!' "

A six-year old was taken to church for the first time. After she returned home her uncle asked her how she liked church. She answered. "I liked the music okay but the commercial was too long."

In one of the American advances a sergeant ordered a colored private to go into a dugout and clean out any Germans that happened to be there. The colored gentleman blanched a bit, swallowed his Adam's apple, and then said huskily, "Ef yo' sees three of fo men come runnin out of dat hole, don't shoot the fust one."

Gold Digger: "Thank you so much for this lovely pearl necklace."

Married Man: "Don't mention it, don't mention it, don't mention it."

"You've just come from a wooden wedding?"

"Yes. Two Poles were married."

A woman invited several friends to a mushroom steak dinner. When Nora, her maid, opened the can of mushrooms, preparatory to making the sauce, there was a slight scum on top.

The time being short, the lady suggested, "Give the dog a little and if he eats it, it's probably all right." Since the dog liked it and begged for more, the dinner was finished.

After the guests had enjoyed their dinner, Nora came in, white-faced, with the dessert and whispered tragically to her employer, "Ma'am, the dog's dead."

There was only one thing to do.

Some time later, when eight people were lying around in various stages of recovery and the doctor had departed with his stomach pump, the lady wearily asked, "Nora, where's the poor dog?"

"Out on the front steps, Ma'am, where he fell after the car hit him."

Clipped from the report of a girls' baseball game: "Everything was going fine for the local girls until the last half of the fifth when all the bags got loaded."

Gal: "Do you ever sell brushes?"

Gob: "No, why?"

Gal: "Well, you'd better get one and start selling. That's my husband at the door."

Wife: "You know, I suspect that my husband has a love affair with his stenographer."

Maid: "I don't believe it. You're just trying to make me jealous."

"Well, doctor, was my operation a success?"

"I'm not your doctor; I'm St. Peter."

We have deep respect for age; especially if it is over eight years and bottled.

There's one thing about being baldheaded—it's neat.

Doctor: "Why do you have 764023 tattooed on your back?"

Patient: "That's no tattoo. That's where my wife hit me with the car while I was holding the garage door open."

Beauty Shop—where men are rare and women are well done.

Wife—Mercy, what's the matter with your face, Jim? You look as if you'd been in a terrible accident.

Jim—I thought I'd get shaved by a lady barber and a mouse ran over the floor.

Judge (to couple): "Caught on the park bench, eh? What are your names?"

He: "Ben Pettin."

She: "Ann Howe."

A little boy found up in an apple tree explained to the farmer, "One of your apples fell off and I was trying to put it back."

A tourist in Nome, Alaska, seeing his first Eskimo noticed a native mother with a blond, blue-eyed baby slung to her back and asked, "Is your child a full-blooded Eskimo?"

"Half," was the native's reply.

"Half Irish? Half Scotch? Half what?" asked the tourist.

"Half Coast Guard," the mother replied.

OIL AND GAS TRADE NEWS

Holds Sales Meeting

More than 80 Lane-Wells executives and sales engineers met for a general sales conference in Houston, Texas recently. Under the direction of James D. Hughes, general sales manager, the company's position and outlook with regard to oil industry activities was discussed. Norman L. Dorn, vice president and chief engineer, gave a full report of the company's development program for increasing service to oil producing companies. Morton T. Higgs, manager of field operations and a newly elected Lane-Wells director, reviewed the company's building and equipment program.

Attending the Lane Wells general sales conference in Houston were more than 80 executives and sales engineers.

Gets New Fabricating Plant

Hammond Iron Works has opened a new fabricating plant at Bristol, Pennsylvania, which almost doubles the steel tank, stack, standpipe, breeching, alloy, and steel plate, etc., fabricating capacity. A feature of the new fabricating equipment in this plant is a planer with a 60-ft bed for gang planing the largest size steel plates. The plant covers 16 acres, with main line railroad siding and near deep-water docks.

Aber Is Distributor

The Aber Company Inc. has announced its distributorship throughout the southwest for Union Asbestos and Rubber Company's industrial insulations. Aber offices are situated in Amarillo and Houston, Texas; Tulsa, Oklahoma, and Shreveport and New Orleans, Louisiana.

Atlantic Forms New Department

The Atlantic Steel Company of Atlanta, Georgia has formed a product engineering department with F. A. Teeple, Jr. as manager. Teeple, who has been with Atlantic since 1934, was formerly superintendent of the company's manufactured products division. His supporting staff will include, Fred O. Reese, Emmett R. Rushin, Lawrence A. Wallace, and Michael F. Wiedl, Jr.

Day Represents OK Fiber

S. D. Day Company, Houston, Texas, has been appointed Gulf Coast distributor for the Oklahoma Glass Fiber Corporation of Tulsa, Oklahoma it was announced by H. T. "Bus" Holland of the glass fiber reinforcement company. The Day Company will serve the territory of Texas, Louisiana, Mississippi, and Alabama.

Richards-Conant Named Sales Representatives

Richards-Conant, Denver, Colorado, sales and engineering firm, has been appointed to represent United Centrifugal Pumps, division of United Iron Works. The Denver organization is headed by J. A. Richards and A. B. Conant.

United has specialized for over 25 years in the design and manufacture of pumps for refinery, processing, pipe line, boiler feed, and other specialized services. Richards-Conant operates in New Mexico, Wyoming, Colorado, Montana, and in western portions of South Dakota, Nebraska, and Kansas.

M. B. Skinner Expands

The M. B. Skinner Company, South Bend, Indiana, manufacturers of pipe repair clamps and saddles, has just broken ground for a plant addition that will increase production space by 50 per cent. This action is the result of constantly increasing sales over the past 10 years and the fast acceptance of new items that have been added to the line since the war.

Named Sales Representative. Jack Ankney, H .C. Smith Tool Company, was recently named general sales manager of the company. He has been engaged in sales work in Sussex and Glenrock fields.

Humble Uses Coatings In Off-Shore Drilling

The New Jersey Zinc Company's latest issue of Paint Progress carries a story titled "Protective Coatings Play A Decisive Role in Search for Oil on Continental Shelf." This very interesting and well-written story reveals the difficulties encountered by Humble Oil and Refining Company in drilling for oil off the Gulf of Mexico. Against an assortment of hurricanes, fogs, rain squalls, and 30-ft waves, the oil men are attempting to protect their steel platforms from the ravages of corrosion. The story also includes two large photos of Humble's search for oil in deep water.

THE UNIVERSITY OF MICHIGAN LIBRARIES

with these MOBILE HEAVY-DUTY UNITS

KWIK-MIX
6-S
DANDIE

PORTABLE 1-BAG MIXER re-mixes every batch...

For top-quality concrete produced at top speed . . . on any location . . . check the extra time and money-saving advantages this handy Kwik-Mix 6-S DANDIE offers you. You get sturdy construction without overweight for frequent moves on your job . . . leaf springs and pneumatic tires cushion the rigid frame against road and operating shocks. It's smooth-trailing, easily spotted by hand at pouring location.

You get thorough-strength mix every batch because the Kwik-Mix re-mixing drum adds a lateral folding action to the customary up-and-down mixing motion . . . completely cement coats each aggregate. Automatic water-measuring tank accurately discharges water to within fraction of a pint . . . when skip raises, water valve trips automatically starting flow into drum at precise moment to eliminate clogging. Power-raised skip and Selective Skip Shaker for faster charging . . . plus tilted Flow-Line discharge chute . . . save seconds every batch, more batches per hour. One man can handle all operations.

For high-speed mixing and hauling, team Kwik-Mix DANDIE mixers with the new Moto-Bug, shown above with 6-S. This new, low-cost power wheelbarrow holds 10 cu. ft. . . . travels 1½ to 4 m.p.h. forward and reverse. Send coupon for complete facts.

DANDIE—Trademark Reg. U. S. Pat. Off.

UTILITY-SIZE 3½-S DANDIE EARNS BIG SAVINGS ON SMALL JOBS

Kwik-Mix 3½-S Dandie pays off on scattered, small-quantity mixing assignments . . . gives you high-quality concrete mixed fast, at low cost, anywhere on your property. It's portable as a wheelbarrow. Balanced, light weight and handy push-down towpole provide safe, one-man handling. Large drum opening and low, 3½' shoveling height give fast, easy charging . . . mean more concrete mixed per shift. Convenient end discharge eliminates backing and turning loaded wheelbarrow . . . gets barrow loaded and on its way with ½ the usual effort. Available with either tilting drum (illustrated), or non-tilting.

KWIK-MIX
COMPANY, PORT WASHINGTON, WISCONSIN
Koehring Subsidiary

Mail today to: KWIK-MIX COMPANY, Dept. PE, Port Washington, Wis.

Send us bulletins on: ☐ 3½-S ☐ 6-S ☐ 11-S ☐ 16-S DANDIES

☐ Also send bulletin on 10 cu. ft. MOTO-BUG (shown at top of page).

Name.....Title.....

Company.....

Street.....

City.....Zone.....State.....

Tulsa Office Set Up

F. H. Maloney Company has opened a new branch office at Tulsa, Oklahoma, to service customers in the Mid-Continent area of Oklahoma, Kansas, Missouri, and the adjacent territory. It is established at 310 Thompson Building. It is under the supervision of Frank L. Mill, district manager, who has had many years of industrial field experience. Mill is well acquainted with the trade in that area, as well as in the Texas-Louisiana Gulf Coast territories. He attended University of Houston and Rice Institute.

Form Engineering Company

The formation of the Russell Engineering Corporation, with offices at 2521 Wroxton Road, Houston, was announced recently by George F. Russell, president. The new firm will specialize in the design and engineering of natural gas and petroleum processing equipment. Russell was assistant professor of chemical engineering at the University of Oklahoma, and associate professor of natural gas and petroleum engineering at Louisiana State University.

Other officers of the new corporation are Warren N. Richey, vice president and chief engineer, and James M. Hoover, executive vice president and secretary treasurer.

Buys Atlas Engineering

Jim Baldwin

The Beaumont Iron Works, subsidiary of American Locomotive, has purchased the Atlas Engineering Works of Houston, manufacturer of oil field valves, and by the end of the summer will have moved the plant to Beaumont, Jim Baldwin of Beaumont Iron has announced. This will merge two established oil field equipment companies.

T. L. Fontaine, president of Atlas, will be in charge of building up a sales organization for products manufactured in the two plants.

Koppers Describes Products

Koppers Company, Inc., Pittsburgh, Pennsylvania has issued a bulletin describing usage of its Bitumastic protective coatings. It tells the story of the Long Beach, California Harbor Department's new pier on which was used the Koppers Bitumastic No. 50. Also included in this bulletin are other examples of the effectiveness of the company's products, Bitumastic 70-B priming solution and enamel, and Bituplastic No. 28.

Expands Distribution

Recent appointment of distributors stocking Blackmer Pump Company's entire product line and service parts has been announced.

Included are Blott-Robb Company, Transmission Machinery Company, and Amco Corporation, all in Chicago. H. O. Link Company in Baltimore, Tri-State Equipment Company in Kansas City, and Avels Sales and Engineering Company in Indianapolis.

Recent Blackmer resident sales representative appointments include C. V. Travis as Eastern division sales manager in the New York office, and John X. Hogan has joined the J. C. Patterson Company in Washington, D. C.

Acquires Leader Iron Works

The controlling interest of the Leader Iron Works Company, Decatur, Illinois, has been acquired by Julius H. Peters, formerly associated with The Colonial Iron Works Company, of Cleveland, Ohio. New officers elected at the first directors' meeting were Julius H. Peters, president and treasurer, E. Donald Peters, vice president, and Clarence J. Warner, secretary.

All three men are graduates of Case Institute of Technology, and formerly employees of Colonial Iron Works Company, Cleveland, Ohio.

"DITCH WITCH" pays for itself!

Digging as Fast as FIVE MEN! it's WISCONSIN-Powered!

Moving to or from location by light trailer or pick-up . . . then digging a clean-cut ditch, 4½" wide, 30" deep on the job calls for ruggedness and compactness, both of which are found in this versatile Wisconsin-powered "Ditch-Witch," made by Charlie's Machine Works, Perry, Okla.

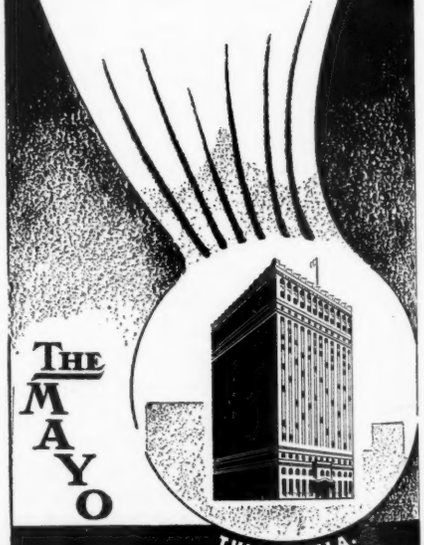
Oil field equipment builders and buyers know Wisconsin Engines require minimum installation space . . . know, too, that equipment performance is no better than its power, which is also why Wisconsin Engines are the power choice again and again. Such service-proved features as tapered roller bearings at both ends of the crankshaft . . . foolproof, any-climate air-cooling . . . and an easily-serviced OUTSIDE magneto with impulse coupling for any weather, quick starting, *put equipment to work sooner . . . keep equipment at work longer . . .* adding up to *more machine hours* on the job and *less manhours . . . more profits* through *less cost.*

Write for details. 4-cycle, single-cylinder, 2-cylinder, and V-type 4-cylinder models, 3 to 30 hp.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 ATLAS BUILDING, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

SLEEP IN AIR-CONDITIONED COMFORT!



THE MAYO
TULSA, OKLA.

- AIR-CONDITIONED
- GARAGE FACILITIES
- ULTRA-MODERN COFFEE SHOP
- CENTRAL LOCATION

United Iron Opens Two New Offices

United Centrifugal Pumps, Division of United Iron Works, has opened eastern headquarters at 225 Broadway, New York, headed by John Re, who has been sales manager for the firm since 1947. Re entered the engineering department of United Iron Works in 1929, and became manager of the pump division in 1937.

John Re

Halley Johnston

The company has also opened a regional office in Houston, Texas, which will be managed by Halley Johnston, who will act in an advisory and supervisory capacity over the activities of the Houston, Tulsa, St. Louis, and Denver district offices. Johnston is a member of the American Society of Mechanical Engineers.

Dale Made Representative

Well Instrument Developing Company has appointed the Dale Company, Los Angeles, California, as its representative for the western states. The Dale Company will handle the sale, rental, and repair service of Widco electric loggers and accessory equipment. They will also render an electrical logging service with Widco logging equipment in wells up to 4000 ft in depth.

Graver Opens Ohio Office

Graver Tank and Manufacturing Company, Inc., East Chicago, Indiana, recently opened a district sales office in Cincinnati, Ohio, at 426 Transportation Building. John R. O'Connor, formerly at company headquarters in East Chicago, was made manager of the Cincinnati office. A mechanical engineering graduate of Purdue University, O'Connor joined Graver 4 years ago.

EMSCO in Canada

Emsco Derrick & Equipment Company announces the appointment of Oil Equipment Ltd. as general distributor for Emsco slush pumps and spare parts in Western Canada. In addition to the general distributor, the following supply companies have been named as new pump sales agents: Dominion Oilfields Supply Company, Ltd., Rocky Mountain Supply, Ltd., and Farmington Supply.

U. S. Steel Puts New Tube Mill in Operation

A new tube mill with an annual capacity of 100,000 tons of electric welded steel pipe, in sizes ranging from 26 to 36 in., began production recently in McKeesport, Pennsylvania, at the National Works of U. S. Steel's National Tube Company. Stock for the mill consists of plates from ¼- to ½-in. in thickness. These plates, whose steel composition runs 0.20 to 0.30 carbon and 0.85 to 1.25 manganese, weigh close to two tons each. Standard length is 40½ ft.; widths will vary from 78½ to 110 in.

Name Sales Manager

Clarence E. Muehlberg has been appointed sales manager of gas products for Rockwell Manufacturing Company. In his 30 years affiliation in the gas utility field, Muehlberg has had varied experiences in all phases of the industry ranging through coal and water gas manufacture, gas works and electric station construction, distribution construction and maintenance, consumer appliance service, domestic, commercial and industrial sales management.

Muehlberg received his degree from the Missouri School of Mines.

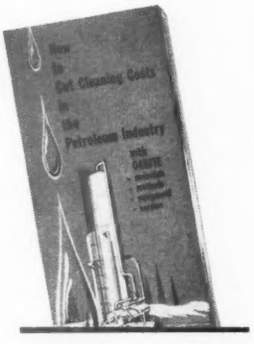
NEW LIFE FOR OLD DRUMS

after only 6 minutes of Oakite cleaning

That's right—used drums restored to first-rate condition—cleaned, rinsed and dried—after only 6 minutes! That's how fast specialized Oakite cleaning works.

Reconditioning barrels and drums the Oakite way has these extra advantages: Fewer rejects . . . more uniform paint stripping . . . better adhesion for new paint. Eliminates paint build-up on steam coils . . . stops clogging of drains and sewers.

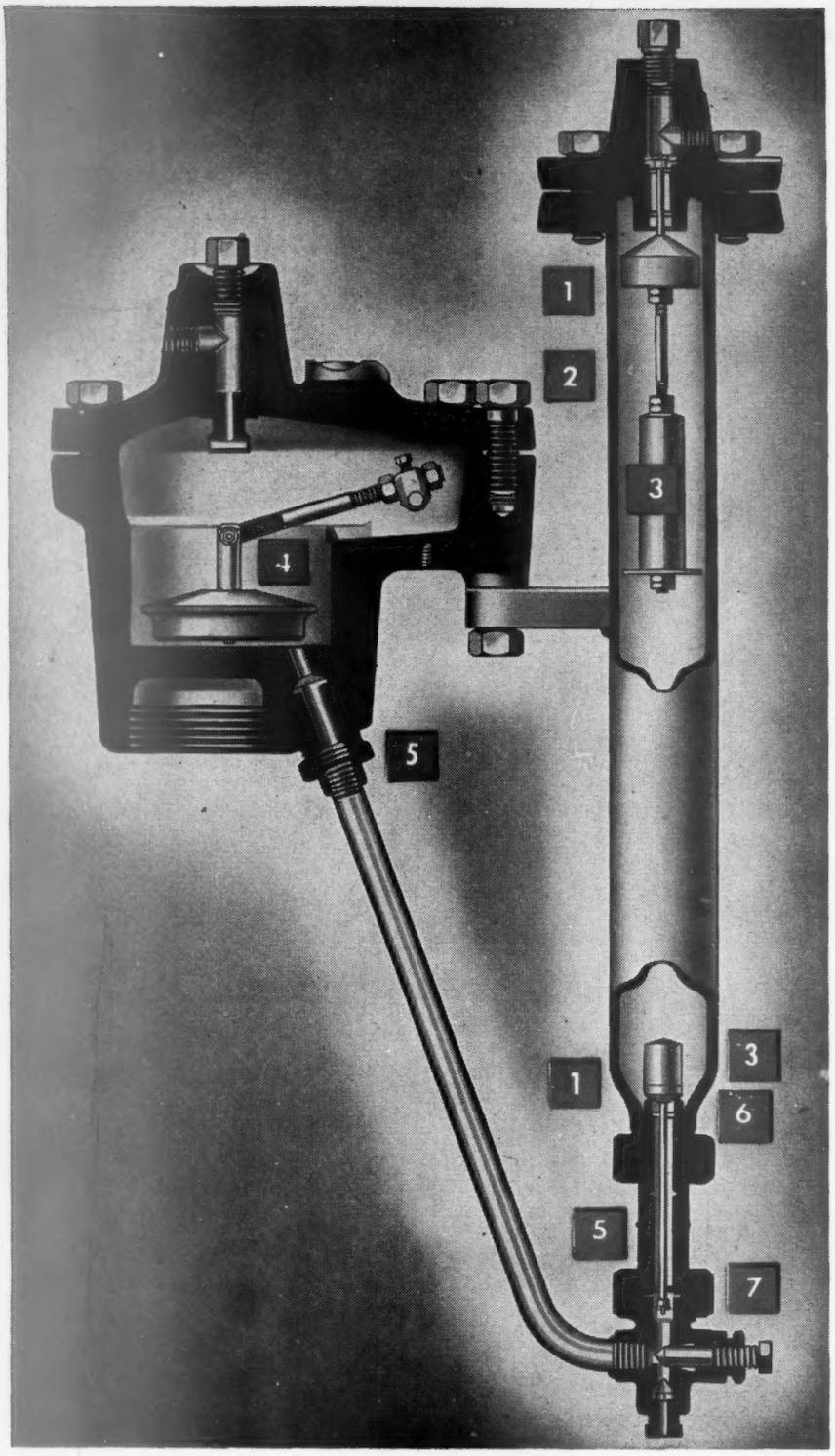
Your local Oakite Technical Service Representative will gladly help *you* get better, faster drum conditioning. Call him today. Or write for free booklet. No obligation either way.



SEND for *free* Booklet. Packed with helpful hints on cleaning, derusting, descaling bubble towers, heat exchangers, pumps, valves, tools, etc.

OAKITE PRODUCTS, INC., 50B Thames St., NEW YORK 6, N. Y.
Technical Service Representatives in Principal Cities of U. S. & Canada

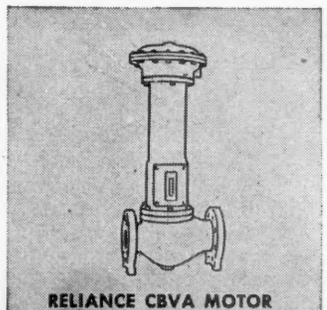
OAKITE
TRADE MARK REG U S PAT OFF
PETROLEUM SERVICE DIVISION



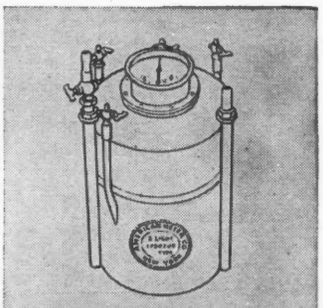
A NEW for 1500

1. **New Mercury Check Valves Stainless Steel Seats**
2. **Extended Hi-Side. Prevents Loss of Mercury on Reverse Flows**
3. **Plastic Check Valve Floats**
4. **Float in Low Side for Convenient Adjustment**
5. **Union Type Connections for Interchangeability of Range Tubes**
6. **Swaged Hi-Side Tube**
7. **New Pulsation Dampener**

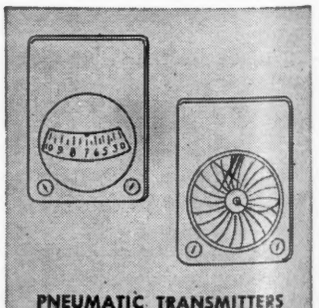
HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)



RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)



DRY TEST METERS
(Bulletin AG-3)



PNEUMATIC TRANSMITTERS AND RECEIVERS
(Bulletin CT-49)

ORIFICE METER
p.s.i. Working Pressure

Among the important operating and service improvements embodied in the American METRIC A-88 Series Orifice Meters are the following:

The mercury float is in the low side chamber, which permits cleaning and calibration with low side cover removed

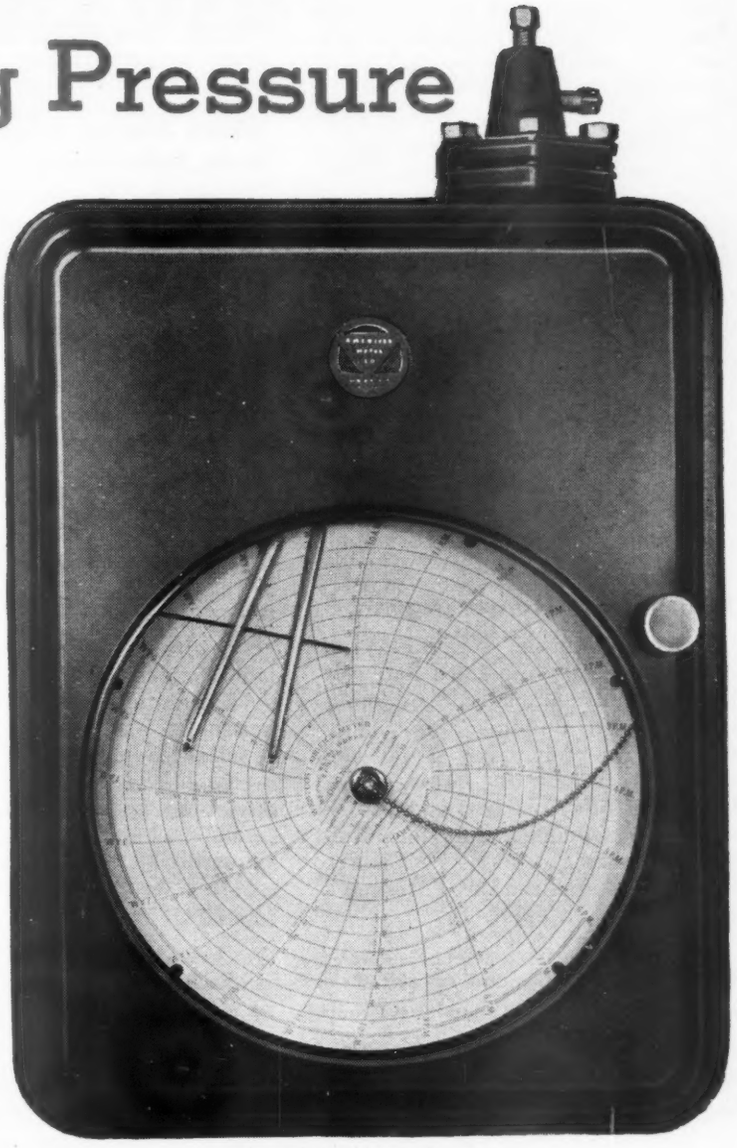
Union type seal tube connections permit interchanging 20", 50", 100" and 200" ranges. Other ranges up to 800" available

Over-range protection is provided by submerged check valve with long guided stem and stainless steel seat

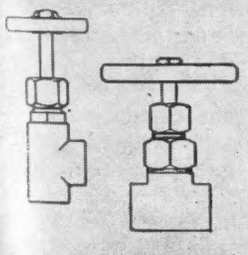
Under-range protection is provided by check valve with stainless steel seat and plastic float in extended high-side chamber

A new Teflon sealed stuffing box with monel shaft requires no grease or other lubrication furnished upon request

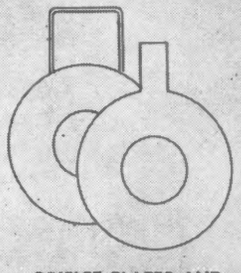
A-88 Series Orifice Meters will handle tough measurement problems. They are rugged, yet simple. They are particularly suitable for applications which must function properly where service inspections may be few and far between. They maintain the American Meter Company tradition of "*sustained accuracy at lower cost.*" Write for Bulletin.



American Meter Company
RECORDING ORIFICE METER
Diff. Range Inches of Water 10—20—50—100—200
Pressure Springs available for all applications



NEEDLE VALVES, SCREWED AND UNION BONNET
(Specification Sheet)



ORIFICE PLATES AND ORIFICE FLANGES
(Bulletin EG-2)

AMERICAN METER COMPANY
INCORPORATED (ESTABLISHED 1836)

60 East 42nd Street • New York 17, N. Y. • Albany • Alhambra
Atlanta • Baltimore • Birmingham • Boston • Chicago
Dallas • Denver • Erie • Fort Lauderdale • Houston
Joliet • Kansas City • Los Angeles • Minneapolis • Odessa
Philadelphia • Pittsburgh • San Francisco • Tulsa
In Canada—Canadian Meter Co., Ltd., Hamilton, Ontario

Core Lab Elects Directors

Ralph W. Parnell, Shreveport, Louisiana, and Ben A. Elmdahl, Houston, Texas were elected to the board of directors of Core Laboratories, Inc., Dallas, following the recent acquisition of controlling interest of the company by a group of employees. Other members of the board include John D. Wisenbaker, president of the company, and two representatives of Case-Pomeroy, New York. Rufe S. Bynum, Midland and J. W. Barbour, Jr., Oklahoma City, have been elected vice presidents, and Claire C. Miller, Dallas, secretary and treasurer.

R. W. Parnell B. A. Elmdahl J. D. Wisenbaker R. S. Bynum J. W. Barbour, Jr.

Services Oil Industry

Taylor Machine Works, Jackson, Mississippi, General Motors diesel engine distributor for industrial applications has recently extended its operation to include GM diesel sales and service to the petroleum industry. The company has been associated with General Motors diesel sales and service since 1940 and their activities cover most of the state of Mississippi.

Insul-Mastic Names Agents

The Insul-Mastic Corporation of America recently appointed four new licensees to its national sales organization, General Building Maintenance Company, Buffalo, New York, and Claude A. Woodard, Tulsa, Oklahoma. The other two companies to be engaged in selling and applying Insul-Mastic products are H. S. Chaffee Company, Buffalo, and W. F. Magann, Portsmouth, Virginia.

Welex Moves Into New Tulsa Office

Welex Jet Services, Inc., of Fort Worth, Texas, are opening offices in the First National Building in Tulsa, Oklahoma under the executive supervision of Carl J. Hochenauer. Hochenauer is also president of Texoma Supply Company of Tulsa, exclusive distributors in the Mid-Continent area for Texasteel Manufacturing Company. Texoma is also moving into a suite of offices in the new First National Building in Tulsa, Hochenauer announced.

Completes Testing Lab

The Bingham Pump Company of Portland, Oregon, has completed its new hydraulic testing laboratory. The laboratory is equipped to reproduce field conditions before shipment of horizontal and vertical pumps and compressors. Capacity of the new testing facilities is capable of taking care of pumps with power requirements up to and including 3000 hp. The new laboratory is also equipped with precision apparatus for extensive research.

U. S. Rubber to Reopen Synthetic Rubber Plant

United States Rubber Company will begin work immediately to reactivate the GR-S synthetic rubber plant at Port Neches, Texas, as requested by the Reconstruction Finance Corporation. It is expected that the plant will be in operation in about three months. One of the first jobs will be to reassemble equipment that was dismantled and put into standby when the plant was closed after World War II. The Port Neches plant has a rated capacity of 60,000 tons but it will be possible to increase this to 75,000 tons if more production is needed, a company official stated.

Buffalo Bolt Company Merges Affiliates

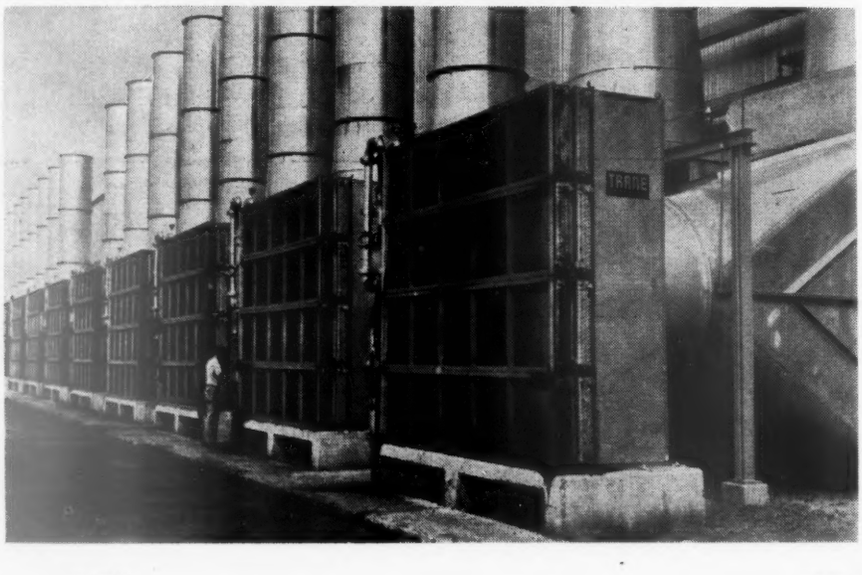
R. B. Flershem, president of Buffalo Bolt Company, has announced that the merger into Buffalo Bolt Company of its operating affiliates, the S. M. Jones Company of Toledo, Ohio, The Eclipse Lawn Mower Company of Prophetstown, Illinois, and Penberthy Injector Company of Detroit, Michigan, has been consummated. The name of the company has been changed to Buffalo-Eclipse Corporation. Operating units of the company will hereafter operate as divisions of Buffalo-Eclipse Corporation under their previous corporate titles.

Officers of the new company will be: R. B. Flershem, president; C. L. Turner, vice president-sales; S. P. Cary, vice president-manufacturing; C. O. Cornell, vice-president-finance; M. B. Jones, C. Neal Turner, and C. B. Johnson, vice presidents; S. C. Wead, secretary-treasurer; W. K. Jackson, H. J. McCallum, K. S. Moore, and F. S. Oatman, assistant secretaries.

Appoints Shuff as Agent

Graver Water Conditioning Company have appointed Evans L. Shuff & Associates as its representative for the Altanta, Georgia territory. The Shuff organization has headquarters at 303 Five Ivy Building, Atlanta 3, Georgia, and is headed by Evans L. Shuff, a graduate mechanical engineer from the University of Kentucky.

Fluid Coolers. The cooling system built for the new Point Comfort aluminum reduction works of the Aluminum Company of America contains 120 giant "fluid coolers" similar to automobile radiators. Each "radiator" has a fan as big as a light plane's "prop," and can get rid of the heat required to warm 22 homes in midwinter. Half a million pounds of aluminum were used in the coolers.



TRADE PERSONALS

Fred Winn, Jr.

Fred Winn, Jr., was appointed sales representative for Diesel Power Company, General Motors diesel distributors of Oklahoma City and Tulsa. Winn has been in the employ of a large petroleum equipment supplier since 1947. He received his BS degree in mechanical engineering at Rice Institute and MS in mechanical engineering at Oklahoma University.

K. C. Winston, former store manager of the Bethlehem Supply Company store at Wewoka, Oklahoma, has been promoted to special representative. **P. W. O'Brien** succeeds him at Wewoka. **H. B. Anderson** has been transferred from Great Bend, to Wichita, Kansas, and promoted to local representative. He will succeed **F. W. Jensen,** who now concentrates his efforts on pumping unit sales throughout the Kansas district. **Arthur Weber, Jr.,** formerly a special representative on machinery sales in the West Texas and New Mexico district, has been promoted to the position of assistant district manager. **G. D. Cannaday,** formerly field representative at Shreveport, Louisiana, has been transferred to Kilgore, Texas, in the same capacity. **H. L. Morton,** of the Shreveport store, has been promoted to the position of field representative. **J. T. Allen** of the Kilgore used material department has been promoted in that department to field representative, and will assist in field inspections and sales.

L. R. Muhlinghause was recently promoted to field representative to assist in the sales work in the Corpus Christi, Texas store area. **J. L. Callaway,** field representative at Houston, has been transferred to Beaumont in the same capacity. **A. M. Rouse** has just recently been employed as a field representative and will be situated at Great Bend, Kansas, to assist in the sales coverage of that vicinity. **W. F. Ware** has recently been employed as a field representative to assist in sales work in the San Angelo, Texas area. Other changes in the West Texas area personnel include the promotion of **J. R. Jones** to field representative at the Hobbs, New Mexico, store; **B. M. Queen** to field representative at Kermit, Texas, store; **R. H. Mathews** to field representative at the Snyder, Texas, store, and **J. D. Barker** and **T. G. Hay,** both of the Odessa, Texas, store, to field representative.

Merton Anunson was named export sales manager for The Four Wheel Drive Auto Company. Anunson has been with FWD since 1935. He was in charge of FWD sales in Europe, Africa, and the Near East until a year ago when he was named administrative assistant to the director of sales.

William D. Craig, formerly assistant district manager for The Continental Supply Company in charge of East Texas operations, has been made district manager for the Rocky Mountain District, with headquarters in Casper, Wyoming. **James R. Chapman** replaces Craig and will maintain headquarters in Tyler, Texas. He comes from the Casper store.

W. D. Craig

William Charles Stringfellow, General Controls, Glendale, California, has been appointed to the Dallas branch office as sales engineer. Other appointments are **Hamilton G. Sudler,** New York office; **Earnest F. Bruegel,** Philadelphia, and **R. Roedder,** Los Angeles offices.

Alexander B. Cloud, American Meter Company, has been appointed district sales manager of the New York territory. Cloud graduated from the U. S. Naval Academy in 1934 and joined American Meter Company in 1936. From 1936 until 1942 he worked at the Metric Metal Works, Erie, Pennsylvania where he was engaged in production, service, and sales work.

A. B. Cloud

Nils Walter Swenson has been named assistant manager of branch sales for the mechanical goods division, United States Rubber Company. Swenson was formerly manager of mechanical goods sales for the company's Buffalo, New York, branch. He will make his new headquarters at the company's New York offices.

F. W. Fisher

C. G. King, Jr.

Floyd W. Fisher has been named manager of stores, for United Supply and Manufacturing Company, and has been transferred to headquarters in the Tulsa, Oklahoma offices. Fisher has been associated with United Supply for 13 years. **C. G. King, Jr.** has been named division manager of the entire Gulf Coast area for United.

E. R. Wisner, The Baldwin Locomotive Works, has been appointed manager, locomotive department. **E. F. Sheehan,** formerly concerned only with the sales of diesel renewal parts, has been appointed manager, renewal parts department. **Andrew Liston,** manager, hydraulic turbine and marine products department, will continue in this capacity, and in addition, will have charge of the sales of all foundries products and the handling of negotiations with the U. S. Government on special products. **M. L. Hall,** formerly manager, testing equipment sales, has been appointed manager, testing equipment department. **George F. Walsh,** who has been sales promotion manager, testing equipment department, has been named sales promotion manager. **R. G. Tabors** will continue as manager, hydraulic press and power tool department, and **R. S. Oberlander** as manager, diesel engine department. **J. V. Breen** has been named manager, order service section and **R. Zerewat,** manager, market research and statistics.

Cameron Iron Works, Inc. has made the following appointments: **Ralph H. McCullough,** secretary-treasurer; **Edmond L. Lorehn,** executive vice president; **Herbert Allen,** vice president and general manager, and **Olle L. Lorehn,** vice president and assistant to the general manager.

L. C. Daniels, formerly chief engineer for the Towmotor Company of Cleveland, Ohio has joined the Buda Company as vice president in charge of material handling division. Daniels formerly worked 20 years as experimental engineer and sales representative for the White Motor Company in Cleveland, Ohio.

G. V. Taylor

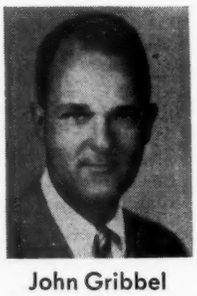
George V. Taylor, Spencer Chemical Company, has been promoted to director of sales development. In his new position Taylor will be in charge of the company's advertising, agronomy, and market research activities. He has been with the company since 1942.

S. W. Collins was appointed sales representative in Oklahoma and Kansas for the Alloy Steel Products Company, Inc. of Linden, New Jersey. Collins recently returned to the Mid-Continent area from New York City where he had represented Pacific Valve Company. Previously he had, for some years, been assistant district manager in the Oklahoma area for Oklahoma Refinery and Machinery Company.

Jack Long was appointed assistant general manager of Oil Base, Inc., Compton, California. He will divide his time between management and sales of Black Magic oil base drilling fluid, White Magic oil emulsion mud, and other mud conditioning products manufactured by Oil Base, Inc.

Lester R. Sagar was recently named process manager of Dearborn Chemical Company. He will supervise production planning and the development of process equipment. Previously a consultant with Booz, Allen & Hamilton, Sagar has also been with the chemical division of Corn Products Refining Company, Linde Air Products, and International Minerals and Chemicals.

R. C. Wiggins was named manager of the Russell, Kansas store where he has been serving as assistant manager for the Continental Supply Company. **R. W. Woodside** was named manager of the New Harmony, Indiana, store, being transferred from Henderson, Kentucky, where he has been floorman.



John Gribbel

John Gribbel, II, was named district sales manager for the Philadelphia sales territory, of the American Meter Company. He was graduated from the Sheffield Scientific School of Yale University, and following graduation was employed by the Philadelphia Electric Company. Gribbel has been employed by the American Meter since 1947 as sales engineer in Philadelphia.

H. R. Gibbons was appointed chief engineer in charge of product design, research, application, and service engineering for the Hyatt bearings division of General Motors Corporation, Harrison, New Jersey. He succeeds **O. W. Young** who assumes new duties as technical assistant to the office of the general manager. Gibbons has been assistant chief engineer for the past 7 years. He joined Hyatt in 1914, after graduating from Stevens Institute of Technology with a ME degree. Young has been associated with Hyatt since 1915 and served as chief engineer from 1928.

L. D. Stack

Loyd D. Stack was recently appointed sales representative in Abilene, Texas for Technical Oil Tool Corp., Ltd., it was announced. A graduate of Texas Technological Institute, Stack spent 5 years in the U. S. Marine Corps, and since the war has gained practical field experience by working for drilling contractors in West Texas.

CARLON

PLASTIC PIPE IS AVAILABLE!

Carlon Plastic Pipe is available in standard line pipe sizes from ½ inch to 8 inches. It is comparable to, and in corrosive conditions it is superior to other types of pipe for lead lines, disposal systems, tank battery hook-ups, gas lines, fresh water lines, salt water disposal tubing and in some cases, production tubing.

Carlon Plastic Pipe Is Used and Has Proven Satisfactory On These Jobs

- GAS LINES
- LEAD LINES
- WATER LINES
- GATHERING LINES
- DISPOSAL TUBING

TELL US YOUR PROBLEM

If you have a problem, either from corrosion or in procuring other types of pipe, tell us about the installation in detail and we will furnish you complete data on Carlon Plastic Pipe, and make recommendations on the type pipe to fill your requirements.

WRITE—WIRE—OR CALL
FOR PRICES AND DELIVERY

GREEN CONTRACTING AND ENGINEERING CO.
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CARTER PRODUCTS CORPORATION, CLEVELAND, OHIO, MFRS.

Pell W. Foster, Jr., was recently named vice president in charge of a newly created equipment division for Foster Wheeler Corporation (New York). This division will comprise the steam, industrial, marine, and condenser departments, which are existing commercial engineering groups serving the power generation, industrial processing, and marine industries. Foster, a director and vice president in charge of production since 1946, will continue as active head of the production and procurement departments.

P. W. Foster, Jr.

J. D. Hudson, Oakite Products, Inc., New York, has been been appointed to the company's petroleum service division staff. He will operate from the company's offices in Dallas. A graduate of Mississippi State College, Hudson did postgraduate work at MIT before entering the refinery construction field in the Louisiana area in 1935. In 1943 he joined the Cities Service Corporation at Lake Charles, Louisiana, remaining with that organization until his appointment by Oakite.

Robert S. Oberlander was named manager, diesel engine department, The Baldwin Locomtive Works. Eddystone, Pennsylvania. Oberlander attended Strayers Business College and Pennsylvania State College Extension School. Upon completion of his schooling he entered the employ of Sharp and Dohme where he served in the machine shop for 4 years. He joined the Baldwin organization in 1941.

R. S. Oberlander

Hamilton Merrill, a vice president and director of Manning, Maxwell and Moore, Inc., has been elected president of the company. Merrill succeeds **Robert Ross Wason,** who died July 7. Merrill became associated with MM&M in 1920 as assistant works manager. In 1928 he became works manager of the Bridgeport plant, and was made a vice president in 1937. He was elected to the board of directors in 1949.

Chester H. Butterfield, vice president of MM&M, has been named vice president in charge of the Consolidated-Ashcroft-Hancock Division, makers of valves, gauges and industrial instruments, succeeding Merrill.

J. R. "Jeff" Walker has been appointed vice president and general sales manager for the petroleum equipment division of Axelson Manufacturing Company, succeeding **Alvin "Dutch" Zwerneman.** Walker has been in charge of the company's Mid-Continent division at Tulsa, Oklahoma. Zwerneman, a former vice president of the company, resigned to return to Houston, Texas, where he plans to enter into business for himself as a manufacturer's agent for the petroleum and allied industries.

K. S. "Ken" Ramey, formerly in charge of Axelson's California sales division, is being transferred to Tulsa as Mid-Continent sales manager. Willard F. "Bill" Goertz of the California sales division will be promoted to sales manager.

Roland E. Smith

Roland E. Smith, Los Angeles, California has been appointed export representative for Advance Oil Tool Company, manufacturers of the Advance air powered tubing spider. Smith was formerly export representative for Atlas-Production.

Freezing Order Applied To

the sale of exhibit space at Permian Basin Oil Show, Odessa, Texas, October 19-22. The available 140,000 square feet of exhibit space has been sold.

A Warm Invitation Is Extended

however, to representatives of the Oil and Gas Industry to visit THE PERMIAN BASIN OIL SHOW, OCTOBER 19-22, ODESSA, TEXAS.

WHERE the latest innovations in drilling and specialty equipment will be on display.

WHERE meetings of organizations basic to the oil industry will be held.

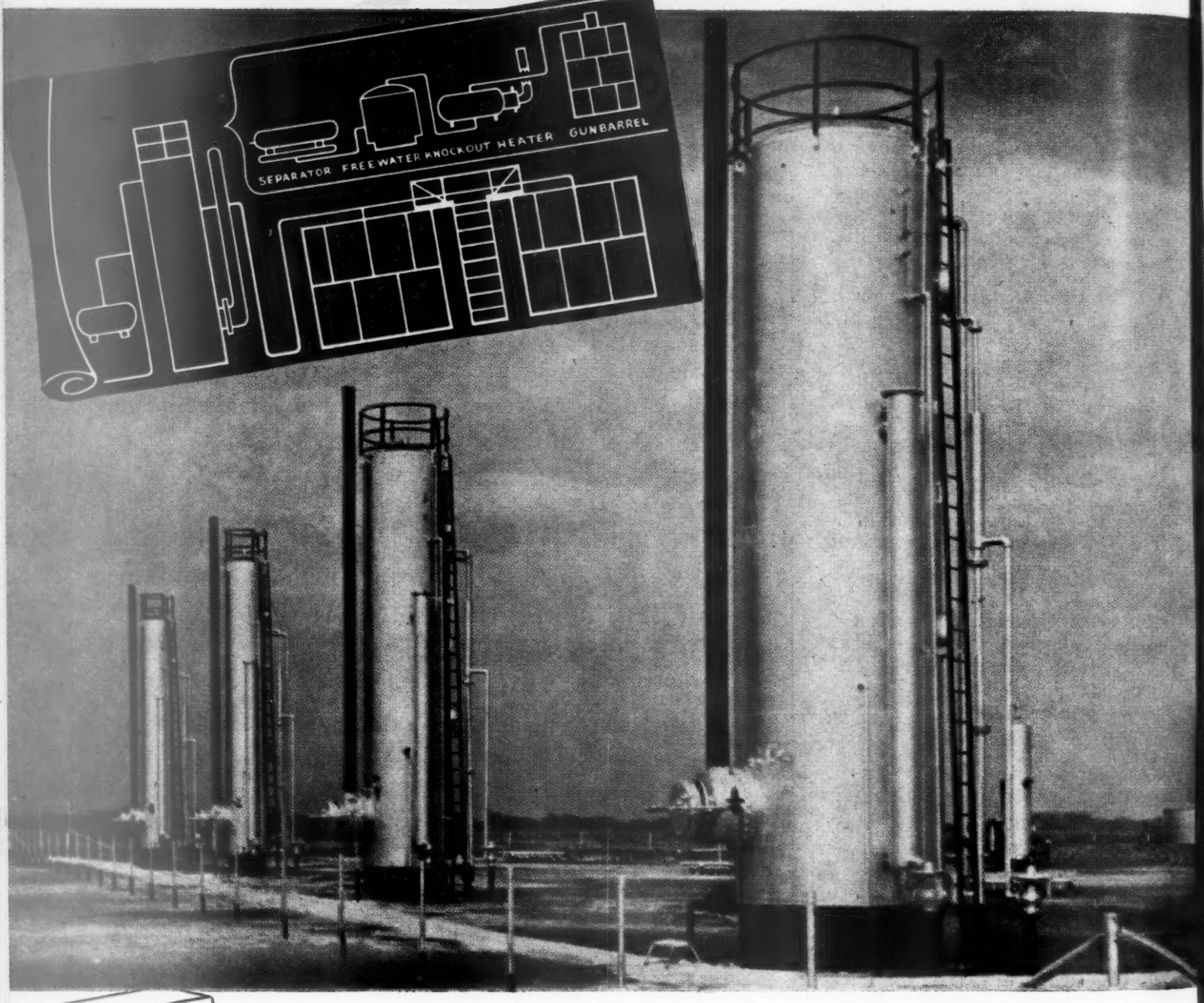
WHERE three big-name bands will play each night for your dancing pleasure.

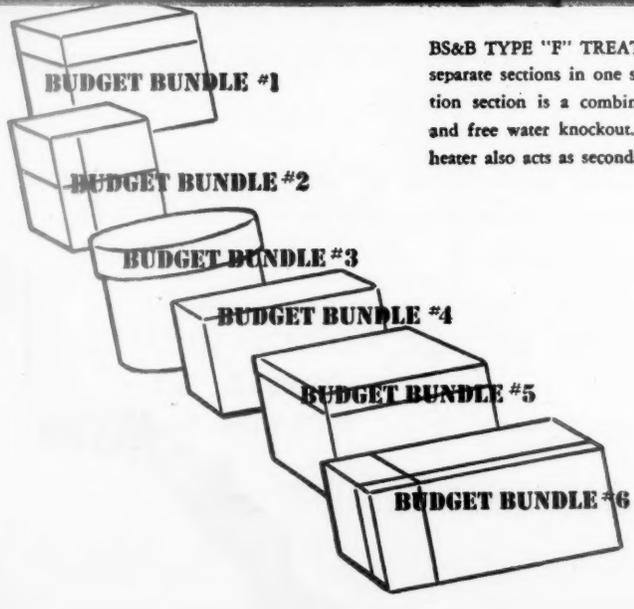
WHERE a Chuck Wagon Barbecue will provide opportunity to renew old acquaintances.

WHERE the friendly communities of the West Texas-New Mexico Permian Basin area hope you will observe Oil Progress Week.

REMEMBER, IT'S "THE OIL FIELD WORKERS' SHOW" AT
ODESSA, TEXAS
OCTOBER 19-22

We've Built a Bundle Within a Bu
in EMULSION TE





BS&B TYPE "F" TREATER combines three separate sections in one shell. The classification section is a combination gas separator and free water knockout. The large capacity heater also acts as secondary water knockout. The settling section is a quiet gas-free zone for final separation. All three are independent of each other. Each can be drained or inspected separately. Handles more gas. Far more easily maintained and serviced. Less gravity loss. Write for details.

It pays to buy

all the way.

a Bundle to Give You a New High
N TREATING RESULTS!

You Can Make Money and Cut Costs, Too with BS&B BUDGET BUNDLE #4

• On many leases, equipment must provide for separation and removal of gas and free water from the emulsion. Then the emulsion may be broken by adequate heat and settling time. A few years ago, four pieces of equipment were required to do the job. Now you can do it... and get better results... with just one! Yes, sir, BS&B's Type "F" Treater treats and then some. It has built-in stabilizing features that assure highest gravity stock tank oil. It is completely and *reliably* automatic. And the Type "F" is most economical and easily maintained in the field.

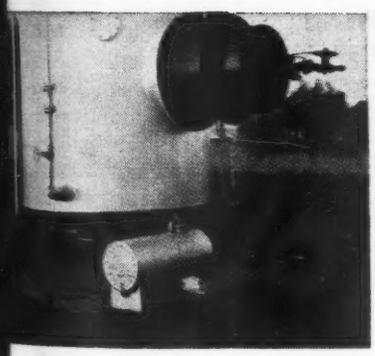
That's why Budget Bundle Four is such a great value. One basic item is cheaper than four.

Then you get the other savings of buying the Bundle... on hook-up and "down" time, in freight costs. Your bookkeeping is easier. One order covers all. Fewer spares are needed, and they are easily obtained at one source.

Further, there is no divided responsibility. Your BS&B Sales Engineer stands ready to aid you, backed by all the facilities and manpower of the world-wide BS&B organization.

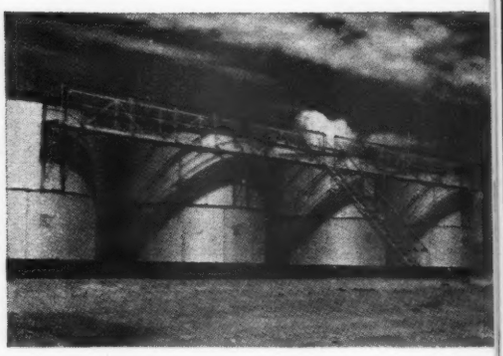
Your equipment dollars go farther when you take advantage of the uniform, made-to-measure, perfectly balanced service of BS&B Budget Bundles!

Black, Sivalls & Bryson, Inc.
KANSAS CITY • TULSA • OKLAHOMA CITY
Cable Address: BLACKSIV, New York



BS&B AUTOMATIC CHEMICAL FEEDER ...positive, diaphragm motor-driven displacement pump delivers precise-timed feeding. Recommended for those problems requiring chemical for successful treating. Injects smoothly, even against high pressures. Compact, simple, long life.

For quickly assembled, leak-tight storage, BS&B BOLTED STEEL TANKS are the long-time standard for the industry. In addition to superior workmanship, BS&B also has highly skilled erection crews to put 'em up right.



Versatile, easily-fitted BS&B SAFWALK walkways and ladders give you working platforms in perfect safety. Non-slip, long life, all-metal. Fabricated to fit with the most ordinary tools right on the spot. Inexpensive, too!

BS&B

MAIL COUPON TODAY
for the complete, fact-packed BUDGET BUNDLE story. No obligation ... get the facts!

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BLACK, SIVALLS & BRYSON, INC. Section 8-22-9
720 Delaware Street **Kansas City 6, Mo. U.S.A.**

☐ Rush me your Emulsion Treating Story on Budget Bundle 4. ☐ What are the other Budget Bundles? ☐ Have Sales Engineer call.

NAME _____

TITLE _____ FIRM _____

STREET _____

CITY _____ STATE _____

Alfred R. Mullis has been appointed manager of the Gulf Coast district office of the petroleum chemicals division of the Du Pont Company with headquarters in Houston, Texas.

Mullis is a graduate in chemical engineering from Rice Institute in Houston. He has been with the Du Pont Company since 1947.

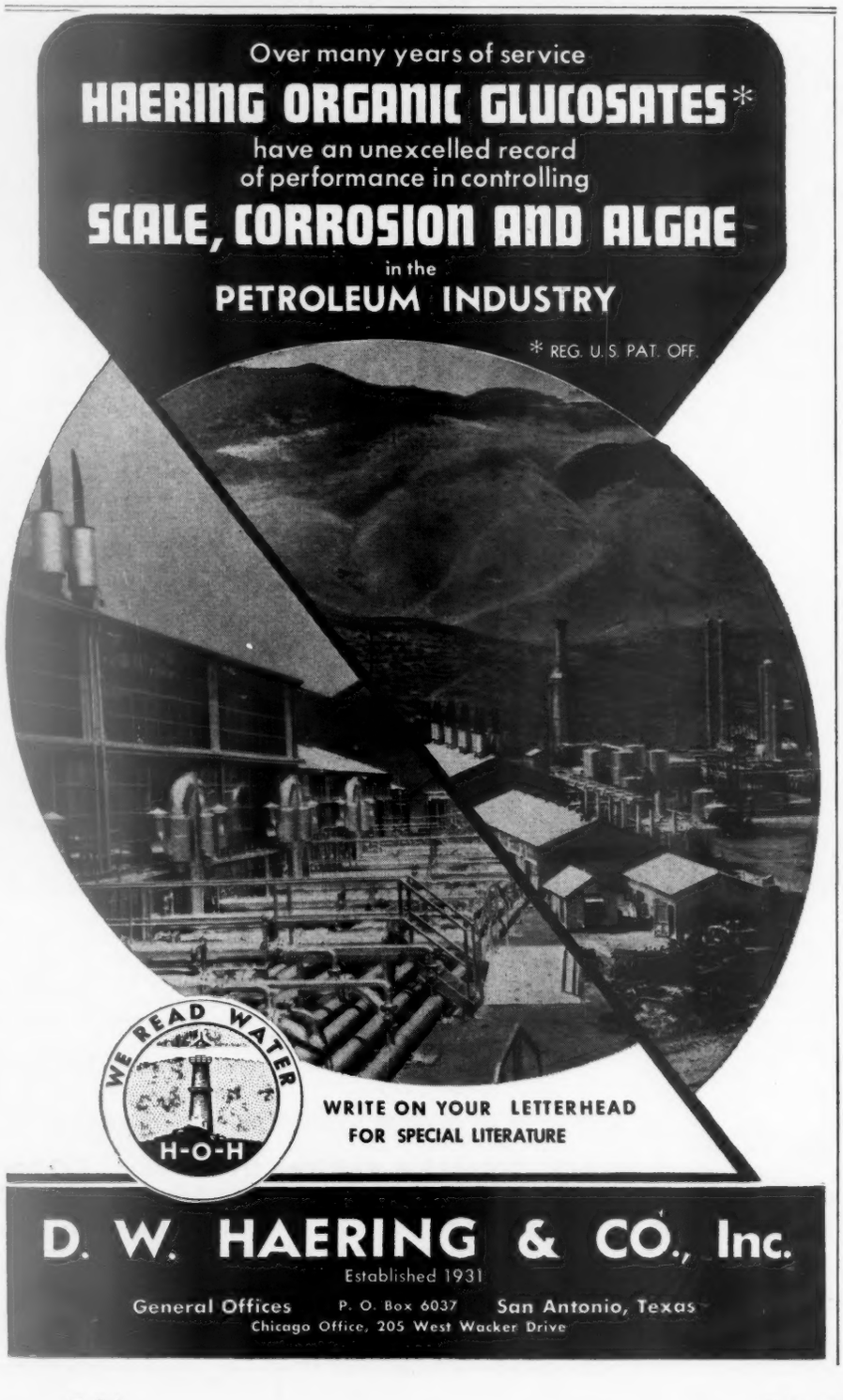
W. R. Ryburn has been appointed manager of sales—seamless products for the Spang-Chalfant division of The National Supply Company.

For the past three years he has been manager of National Supply's drilling equipment sales at the company's general sales offices, Toledo, Ohio. Ryburn began with National Supply in 1928. He succeeds **R. M. Burk** who recently left the company to enter the oil business.

Raymond H. Cramer has been named general manager of the Hyatt Bearings Division of General Motors at Harrison, New Jersey. He succeeds the late **H. O. K. Meister.**

Cramer has been works manager of the Hyatt Bearings Division. He has been with Hyatt Bearings Division since 1924.

Meister joined Hyatt in 1914, becoming general manager in 1937.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HAERING ORGANIC GLUCOSATES*
have an unexcelled record
of performance in controlling
SCALE, CORROSION AND ALGAE
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WRITE ON YOUR LETTERHEAD
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D. W. HAERING & CO., Inc.
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Chicago Office, 205 West Wacker Drive

H. Cooper Kinney has been appointed director of purchases of Republic Supply Company. **R. E. McCullough** will continue in his position as purchasing agent. Prior to his elevation, Kinney had been manager of Republic's Gulf Coast district with headquarters in San Antonio. **I. R. Knight,** formerly Kinney's assistant, succeeds him as district manager. He began with the company in 1917 in the sales department shortly after his graduation from Mississippi A & M.

John F. Wallace, formerly vice president, Brennan Advertising Agency, Houston, Texas, has been appointed to head the industrial advertising division of the Dallas office of Watts, Payne-Advertising, Inc. Wallace formerly served as advertising representative for *Drilling Magazine.* He will specialize in trade paper, direct mail, and other types of advertising and sales promotion for manufacturers of industrial equipment and supplies.

Wren Malone

Wren Malone has been appointed to the sales staff of the Chicago branch of Enterprise Engine & Machinery Company. Malone was recently regional manager of the Superior Engine Division of National Supply Company's Springfield, Ohio, branch. He will serve in the Illinois, Ohio, Indiana, Michigan, and Wisconsin area.

R. R. Rieke, former manager of the Gulf Coast area for Schlumberger Well Surveying Corporation, has been named to the newly created position of general sales manager for Schlumberger. Immediately after he graduated from the University of Iowa in 1936, Rieke joined the Schlumberger organization as field engineer.

E. F. Stratton, former Rocky Mountain area manager, has been moved to Houston to take charge of two former areas that have been combined to form Schlumberger's southwest area.

Richard H. Frizzell was appointed sales manager of the structural products department of the Wickwire Spencer Steel division of The Colorado Fuel and Iron Corporation. In 1933, prior to the merger with The Colorado Fuel and Iron Corporation, Frizzell joined the then Wickwire Spencer Steel Company. He succeeds to the position of **G. L. Crawford,** who will devote his full efforts to that of sales manager of the division's Buffalo sales district.

J. Lawrence Kennedy has been elected vice president and secretary of The Kennedy Valve Manufacturing Company, Elmira, New York. He has also been elected to the board of directors of the company.

Before joining the Kennedy organization in 1949, Kennedy was vice president of Charles L. Rumrill and Company, Rochester, New York advertising agency.

William Hatton and **Frank B. Powers** have been elected vice presidents of Federal Telephone and Radio Corporation, Clifton, New Jersey.

Hatton previously served as director of manufacturing and engineering of I. T. & T. and its world-wide manufacturing and sales affiliate, International Standard Electric Corporation. His service with I. T. & T. and affiliated companies dates to 1919.

Powers joined Federal last year as director of manufacturing operations. Formerly assistant vice president, production of the American Car and Foundry Company, he has had more than 20 years of service in the engineering and manufacturing fields.

Reginald Rowand has been appointed manager of the National Lead Company Baroid Sales Division's production department. Rowand went to Baroid in 1945 as superintendent of construction and maintenance.

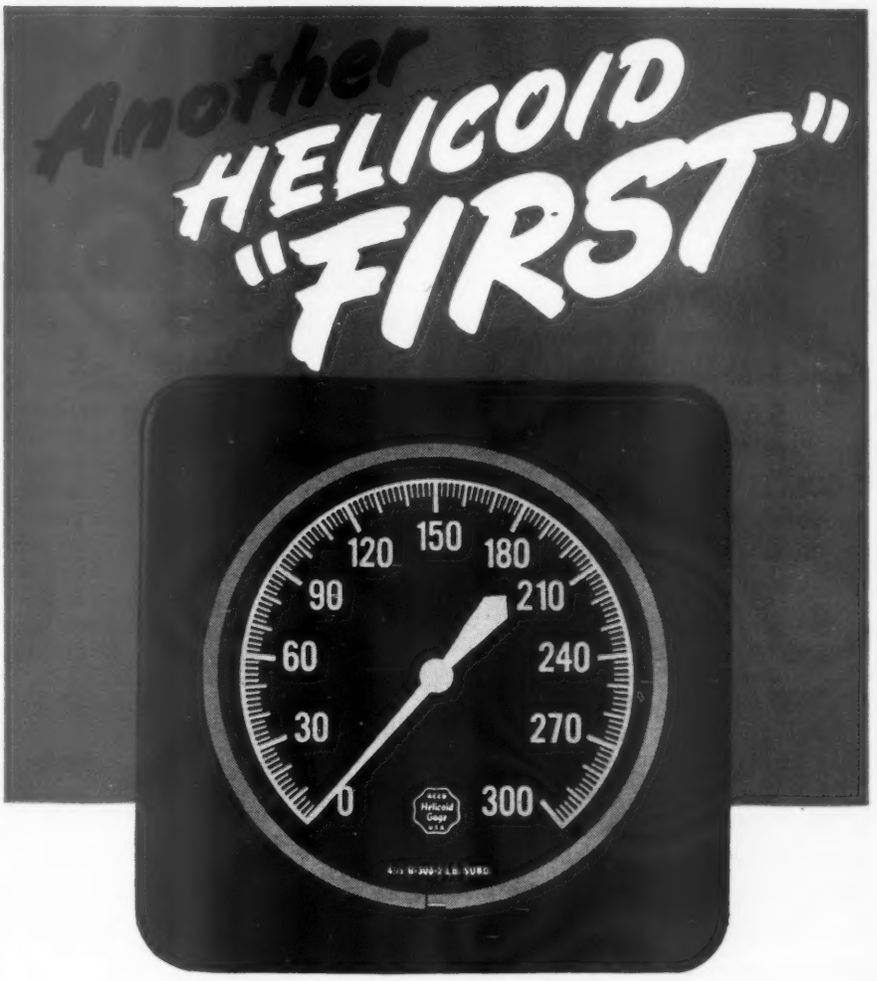
Earl H. Murchison, former superintendent of the El Portal, California, barytes mines and plant, replaces Rowand as superintendent of the Magnet Cove, Arkansas, barytes operation. Murchison became connected with the Cartersville, Georgia, plant in 1919.

Robert B. Spitzer, general superintendent of the Rossi-Merced mines and plant, takes on the additional duties of superintendent of the El Portal mines and plant.

Erling Klafstad has been named assistant director of engineering for Manning, Maxwell and Moore, Inc., Hancock valves and consolidated safety and relief valves. Born in Norway, Klafstad attended Oslo Technical, Norway, Franklin Institute, and Lowell Institute, MIT. He was previously vice president in charge of engineering and manufacturing for the Crosby Steam Gage and Valve Company.

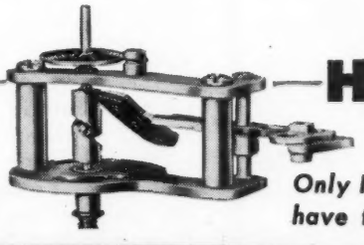
Frank L. Myers has been appointed general sales manager of the fibrous products division of Union Asbestos and Rubber Company, Chicago, with headquarters of the division at Cicero, Illinois.

Prior to joining Union Asbestos in 1948, Myers was with Owens-Corning Fiberglas Corporation.



NEW SQUARE, FLUSH CASE GAGE

- ideal for symmetrical panels
- saves space, improves appearance
- 4½", 6" and 8½" dial sizes
- all standard pressure ranges
- with or without internal illumination
- insist on HELICOID GAGES in the new square flush case for that next panel job



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Only Helicoid Pressure Gages have the Helicoid Movement

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Dollars in Power and Maintenance Costs with

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Pure Colloidal Concentrate

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NEW REFINERY ACRAGAGE

Removing Waterproof Blowout Disc exposes entire mechanism for inspection, repair or recalibration — ***without removing dial.***

WRITE FOR THE NEW ACRAGAGE CATALOG, "C-50"

EASIEST TO MAINTAIN

CLAPP INSTRUMENT CO., Webster, Mass.

W. T. Cushing, Jr.

Allen H. Jones

W. T. Cushing, Jr., has been appointed manager, drilling equipment sales for The National Supply Company. A graduate of the University of Michigan, Cushing joined National Supply in 1940. He spent 5 years in the engineering and sales departments at the company's Toledo, Ohio and Torrance, California, plants and 2½ years as production equipment engineer in the plant products division, Houston, Texas.

In 1947 he was transferred from Houston to Casper, Wyoming, as division engineer of National's Northwest and Canadian districts. Later he became division sales manager for the same territory. Cushing succeeds **W. R. Ryburn,** just appointed manager of sales of seamless products for the Spang-Chalfant division of National Supply.

Allen H. Jones is manager of Peabody Engineering Corporation's newly-opened Chicago office. Although the Peabody Engineering Corporation maintains offices abroad, the Chicago office is the first company-operated district office in the United States.

William H. Larkin has joined Air Preheater Corporation's sales organization in New York. He formerly was with the Sturtevant division of Westinghouse Electric Corporation in charge of power plant work for the eastern district, with headquarters in New York City.

Larkin received a BS degree in mechanical engineering and business administration from Harvard University in 1925, and a master's degree in business administration from Harvard in 1933.

Dr. Arthur M. Edwards has been named to the newly-created post of medical director of American Steel and Wire. Edwards will administer the medical program for all Wire Company plants including those of the Cyclone Fence division.

He attended Lawrenceville School for Boys and Princeton University. He received his medical degree from the medical school of Louisiana State University in 1938.

J. F. Lingeman was recently appointed manager of purchases and production, Dearborn Chemical Company.

Lingeman was graduated from Purdue University in 1923 and joined Dearborn's laboratory staff in 1925 as a chemist. He was made assistant factory manager in 1934 and was appointed assistant to the vice president in February of this year.

John C. Coonley has been appointed assistant manager of the American Car and Foundry Company's valve division. He will make his headquarters in Detroit.

Coonley was with the Walworth Company as saleman, engineer, and tool design superintendent for many years and in 1940 became assistant works manager of the Heald Machine Company of Worcester, Massachusetts, remaining with that company until his appointment to the executive staff of ACF.

A. D. Stephenson, Jr., has been named as assistant to the chief engineer, **M. M. Livingston,** Merla Tool Corporation, Dallas, Texas.

Stephenson, a recent graduate of Southern Methodist University engineering school, will concentrate on experimental design and the development of modern techniques of gas lift production.

Carlos Bartolero has been appointed to the position of project sales engineer of the pump division, Byron Jackson Company. Bartolero will make his headquarters in Los Angeles, but will spend most of his time in the field. His work will primarily be concerned with problems of pumping in the petroleum processing industries and in the pipe line field.

Bartolero was associated with the Byron Jackson Company for eight years, from 1928 to 1936, and has been active in the pump field since that time.

William R. Sandberg has been appointed general sales manager of Phoenix Manufacturing Company, Joliet, Illinois, and Catasauqua, Pennsylvania. He will supervise sales and sales promotion for all four of the company's divisions — horse shoe, flange, forging, and Moldit.

H. L. Bilsborough, assistant marketing director of A. O. Smith Corporation's domestic water heater division, has been assigned to head water heater sales in the West Coast states. He will make his headquarters in Los Angeles.

Formerly with the Fairbanks, Morse and Iron Fireman sales organizations, Bilsborough joined A. O. Smith in 1944 as head of stoker sales.

Wilmer H. Cordes, manager of market development and advertising of American Steel and Wire Company, has been named general staff manager of the company's sales department. He succeeds **Paul L. Lindsay,** recently appointed Cincinnati district manager of sales.

Cordes, a native of Chicago, has been associated with American Steel and Wire since he began at the age of 16 as a messenger in the company's Chicago sales office.

R. V. Gunther has been named assistant production manager and **L. G. Janzow,** chief engineer, manufacturing division of Southwestern Engineering Company. **James F. Geary** has been appointed as chief engineer, construction division.

Gunther has been with SWECO for 8 years. Beginning with the company in 1942 as detail draftsman, he has worked as inspector, job engineer, and senior engineer.

Janzow joined SWECO as junior engineer in 1936. He advanced to shop inspector and was later promoted to the position of design engineer, which he has occupied until the present time.

Melvin DeGroote, vice president of the Petrolite Corporation, Ltd., Tretolite company division, was awarded Ohio State University's Lamme Medal at the commencement exercises.

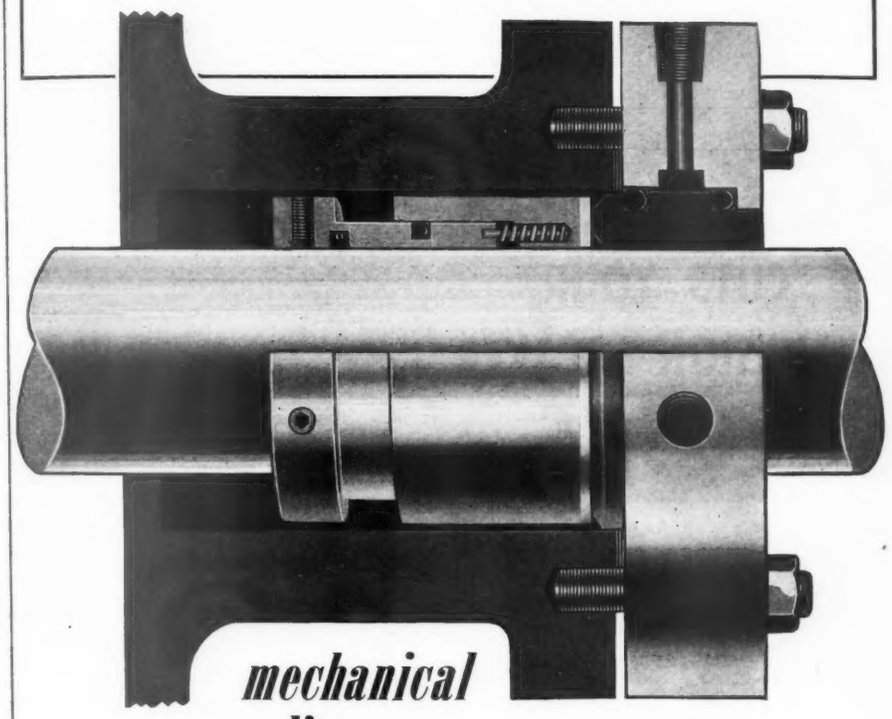
The Lamme Medal is one of Ohio State's highest awards, given annually to a graduate in recognition of "meritorious achievement in engineering or the technical arts." DeGroote was graduated, in the class of '15, with a BS in chemical engineering, and later earned the professional degree of chemical engineer.

James Muir Aitken, Sr., assistant manager of the machinery and export division of the International Derrick and Equipment Company, Dallas, Texas, died suddenly from a heart attack while attending a sales conference in Beaumont, Texas. He had been with the IDECO for more than 24 years, beginning with them in Columbus, Ohio, in 1926 and moving with the firm to Dallas, Texas, in 1946.

Jim C. Chase has been named manager of the recently expanded Dri-Cooler sales department of The Marley Company, Inc. He has been stationed at the general offices in Kansas City, Kansas, since joining the company late in 1948.

Before coming to The Marley Company, he was the Southwest district manager for the Aerofin Corporation working out of Dallas.

High Pressure Sealing for Light Hydrocarbons



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DURA SEAL (The Perfect Seal — Rotates with the Shaft)

TYPE-P.S.

Perfect Sealing on pumps handling light hydrocarbons is being recorded wherever this new custom-built mechanical seal is being used. DURA SEAL —Type P.S. provides non-lubricated sealing up to 600 lb. pressures. Consider, and compare, these features: It can be installed on your present equipment . . . requires no special sleeves or machining . . . no added lubrication system is needed . . . made of selected materials to operate under YOUR particular conditions.

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MILWAUKEE • NEWARK • NEW ORLEANS • PITTSBURGH • PORTLAND, ORE. • ST. LOUIS
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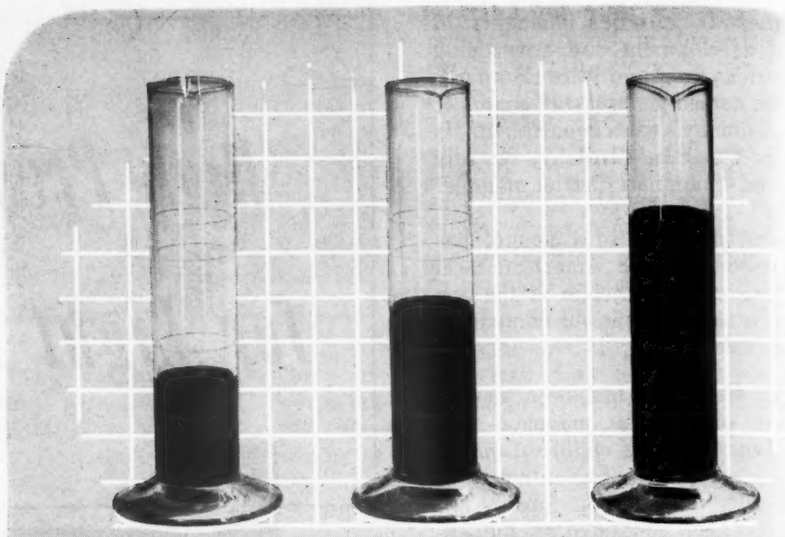
CUTS YOUR EMULSION-BREAKER COSTS



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3 units of a Visco Class I *high quality* formula.

5 units of a medium-priced emulsion breaker.

7 units of a low-priced emulsion breaker.

In each instance, Visco Class I is the highest-priced chemical—but the lowest in cost per barrel of dry oil!

Quantities above were determined from controlled tests in the field and in the Visco Laboratories. Oil treated contained emulsion which could be satisfactorily broken by all three formulas. This proof of the real economy of Visco Quality formulas is even more dramatic on leases where emulsions encountered are more difficult and sometimes impossible to break with lower grade formulas...

You can put Visco Quality to work on your leases promptly—Call Houston, CAPITOL 7300, collect, for fast action. Remember: By paying too little for treating chemical you may be paying far too much for pipeline oil!

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Visco VS SOLVENT

Visco VS was developed for our own use as a solvent for wax, grease, lube oils, paint, oil-treating chemicals, and fusible or soft resins. It is so good, it has been made available to the whole petroleum industry! Will not harm skin, wood or metal. Available now in 5-gallon tins and 55-gallon drums.

Visco CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating compounds for use in the breaking and resolving of oil emulsions, and to grant licenses for such use, under the following United States patents: 1,859,562; 1,860,563; 1,912,330; 1,937,259; 2,050,638; 2,050,640; 2,208,589; 2,214,783; 2,214,784; 2,225,189; 2,303,414; 2,307,813; 2,318,034; 2,318,035; 2,321,056; 2,335,554. Re 20,717 and patents pending. Any purchaser of Visco Oil Treating compounds is authorized to use the same in the treating, breaking and resolving of oil emulsions in accordance with the above patents. The royalty for such use is included in the purchase price. Visco Products Company is authorized to and is willing to grant licenses on a royalty basis, to all companies, and to others desiring to practice the patented subject matter, under any and all of the above patents, permitting the user to purchase the oil treating compounds at will from any vendor, and to prepare the compounds for use under the above patent or patents, at a royalty charge of 20 cents per gallon. Application for license should be made to Visco Products Company, Houston, Texas.

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

(1) Bolt Die

The Ridge Tool Company, Elyria, Ohio, announces a new tool, the Ridgid 00R-B Bolt Die, consisting of a ratchet drive ring and handle with 10 die heads fitted with ¼-in. to 1-in.

button dies, both National Coarse and National Fine Thread available. This compact set has a patented carrier that makes it easier to keep die heads from being scattered and lost. Button dies are easily reversed for threading close to bolt shoulders or heads. No adjustment is said to be needed for standard threads; with easy adjustment for undersize or oversize threads. A handy related tool is the new Ridgid 3-way Bolt Dies No. 33B, which offers 3 useful sizes, ⅜-in., ½-in., and ⅝-in.

(2) Stationary Diesel

A new series of smaller, heavy-duty stationary diesel engines has been announced by Enterprise Engine and Machinery Co. They are designated as the Enterprise M-series diesels. Built in 3, 4, and 6 cylinder models with 8-in. bore and 10-in. stroke, these engines range from 68 to 240 hp at medium speeds of 450 to 750 rpm. All models are of the 4-cycle design. The M-series extends the lower hp range limit of the Enterprise diesel line from its previous range of 180 to 1755 hp and provides high economies of installation and operation for a much broader field of stationary and portable industrial applications.

The result of more than four years research, engineering, plant and field testing, the M-series embodies all of the more advanced design, metallurgical and operational developments in the diesel engine field. These are compact, rugged power plants, designed for continuous, heavy-duty service with minimum maintenance. Small space requirements contribute to the outstanding versatility of these medium speed, high capacity engines, while flexibility of attachment to many types of driven equipment and auxiliaries is made possible through simplicity of basic design.

(3) Variable Speed Motor

For users of fractional horsepower motors, a new design has been developed by U. S. Electrical Motors, Inc. It combines in one unit a Varidrive that permits instant change of speed in a ratio of 1 to 10 and a heavy duty Syncrogear for increasing the torque. It is U. S. Motors' Type VA-GD and is available in ¼, ⅓, ½, and ¾ hp. Speed ranges are from 10 to 10,000 rpm.

The frame of the Varidrive is cast aluminum. A new type of dial control permits instant speed change by turning the handle less than one revolution. Slippage is prevented by use of the improved Autotaut belt tensioner.

Get Full Details of September, 1950, Listing—Check and Mail Coupon to

THE PETROLEUM ENGINEER
P. O. Box 1589, Dallas, Texas

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		

NAME ..... TITLE .....

COMPANY NAME .....

STREET ADDRESS .....

CITY ..... ZONE NO. ..... STATE .....

(4) Storage Tank

Manufacturing rights are now being licensed to steel tank fabricators and erectors for a new type of pressure storage tank by Marine Service Company of Compton, California, an affiliate of the Vapor Recovery Systems Company. This new tank was invented by A. Caquot, a French engineer, and requires less steel than any other type pressure storage tank of the same capacity, states the manufacturer. It operates on the principle of a geometrically perfect shape and variable storage pressures dependent upon the quantity of product in the tank. The tank shell has double curvature and is shaped like a drop of water on a flat surface.

When the standard design tank is being filled, it is automatically maintained at 2½ psig until the 40 per cent rated capacity level is reached, after which it is maintained at 5 psig. When emptying, it automatically reduces pressure to 2½ psig at the 40 per cent rated capacity level. Vacuum relief is at 2 oz.

All tanks are subjected to tests of 150 per cent of maximum working pressure. All sizes are designed for an excess of 10 per cent of rated fluid capacity for compressed vapor storage.

(5) Control Drive

A characterized control drive that can be "tuned" to the requirements of a special application is the latest development of Bailey Meter Company, Cleveland, Ohio. This completely enclosed air-operated drive

makes it possible to parallel characteristics of a driven device with characteristics of other equipment thereby securing a unified system, states the company.

The Bailey control drive consists of a double acting air cylinder (with rigid supporting stand and enclosure) a positioning relay, and a manual operating wheel or lever. The drive is claimed to require only .10 psi change in control loading pressure to deliver full supply pressure to the piston in the air cylinder.

(6) Diesel Engine

A new light weight diesel engine is now being manufactured by Detroit Diesel Engine Division of General Motors. The new engine, designated the "110" because of its 110 cu in. displacement per cylinder, is a 6-cylinder, 2-cycle unit rated at 275 hp, states General Motors. The "110" is built to meet the higher power requirements of large earth-moving vehicles, general industrial, oil field, and marine equipment.

Horsepower rating of 275 at 1800 rpm is attained with a bmep of 92 psi. Bore is 5 in. and stroke, 5.6 in. Features include blower scavenging with a gear-driven centrifugal blower supplying more air for the cylinders than is needed for combustion. The blower is situated at the rear of the engine, above the flywheel. The blower impeller is an aluminum alloy forging 9 in. in diameter and is of the open type with radial vanes. A spiral air inlet helps maintain its efficiency. GM unit injectors (one for each cylinder) pump, meter, and atomize the fuel, and are easily removed for inspection or exchange.

Take a Look Inside
With Scottie McBlock
Divider plates between each ALLOY STEEL FLAME HARDENED sheave bolted top and bottom minimize deflection of center pin.
HYATT HI-LOAD BEARINGS for maximum radial capacity . . Bronze thrust plates and grease retainers.
Ample ALEMITE lubrication supplies each bearing.
Weight concentrated below center of lift for . . . A FAST TRUE FALL
TYPE RP TRAVELING BLOCKS
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(7) Adjustable Dial

Adjustable dials are now available for the time delay relays manufactured by A. W. Haydon Company of Waterbury, Connecticut. Ease of adjustment is one of the features of the new adjustable dial time delay relay. The time can be changed easily, but once set, it is positively locked.

Flexibility of design allows for the addition of radio interference filtering and a governed motor on d-c models. Clutch holding contacts for a push button start can be supplied on either the a-c or d-c models. New relays are available for surface or flush type mounting.

(8) Brazing Alloy

The Wall Colmonoy Corporation, Detroit, Michigan announces a heat and corrosion resistant alloy for brazing stainless steels. This material is a stainless type that may well revolutionize many phases of the brazing industry. The joint of a stainless steel assembly brazed with "Nicrobraz" possesses equal strength at 2000 F plus better corrosion and oxidation resistance than the parent metal. It can be used to braze 300 and 400 series stainless steel, Inconel, S-590, Monel, alloy steels, tool steels, carbon steels, and special stainless steels. An assembly to be brazed with Nicrobraz is prepared the same as for copper brazing. It has been found that the joint clearance should not be over .002 in. where highest quality joints are desired.

(9) Lever Gate Valve

Jenkins Brothers, New York, N. Y., have introduced a rapid-action, bronze lever gate valve. The Swingtite has ball and socket design double discs which adjust readily to seat surfaces. Guide rims (A) on these discs rotate freely on the guide tracks (B) cast in the body, as the valve opens or closes. This roller action provides a self-cleaning and polishing effect, and also distributes the wear, since the seating position of the discs changes with each closing. This rolling disc and track construction assures accurate seating with continual tight closure, and prevents rapid, uneven wear of the discs. It is especially recommended for use in oil refineries, textile finishing, chemical and food industries, paper and pulp mills.

(10) Vertical Turbine Pumps

A new line of vertical turbine pumps has been developed by Worthington Pump and Machinery Corporation. Capacities from 50 to 15,000 gpm are available. The new models, states the manufacturer, develop maximum performance per size and overlapping coverage allows selection of a unit for nearly any capacity and head condition at peak efficiency. They are suitable for a wide variety of services, including installation in wells for irrigation, industrial water supply, for installation in sumps, tanks, reservoirs, refinery products.

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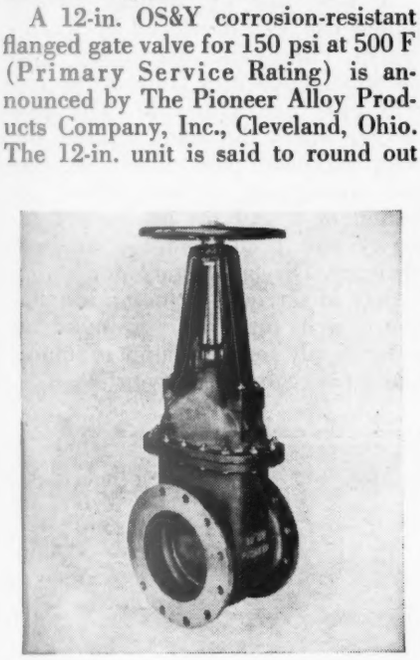
(11) Flanged Gate Valve

A 12-in. OS&Y corrosion-resistant flanged gate valve for 150 psi at 500 F (Primary Service Rating) is announced by The Pioneer Alloy Products Company, Inc., Cleveland, Ohio. The 12-in. unit is said to round out



Pioneer's corrosion-resistant gate valve line, providing a complete range of sizes from ½ in.

Made with outside screw and yoke, the 12-in. valve is available in type 302, 304, 316 stainless steel and Pioneer metal for handling specific acids and corrosive situations. Valves are heat treated for added corrosion resistance, the manufacturer states. Face-to-face dimension of the flanged valve is 14 in. All alloy except handwheels and bronze bushings, the valve is equipped with type 303 or 304 stainless steel bolts, both gland and bonnet.

(12) Welding Machine

A new, completely unitized automatic welding machine especially designed for production welding and hard-facing, is being built and sold by Leader Welding and Manufacturing Company, Berkeley, California. Known as the "Leader," the machine incorporates a 500 amp ac welder, an automatic welding head and a positioner having accommodations for both horizontal and angular mounting of the work. The unit, as sold, is complete, ready to use and requires only to be connected to 220 or 404-v ac power line, the company states.

The ac power supply contains two windings—the heavy duty side supplies the automatic head with variable heats of from 100 to 500 amp. A separate stinger winding of 120 amp capacity is always ready for track welding operations, aiding set-ups.

The automatic head handles all sizes and types of automatic wires and has provisions for manual step-over control for spacing weld beads as well as horizontal travel along its supporting arm.

(13) Gas-Liquid Separator

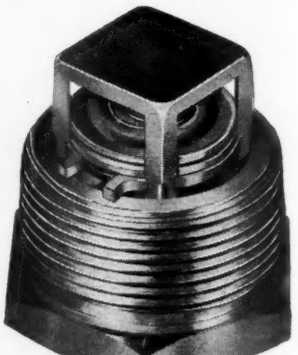
The Parkersburg Rig and Reel Company, Parkersburg, West Virginia, has announced the development of the Hydracepter, a new device for the prevention of gas line freezing by the removal of free water, the cause of hydrate formation, from the gas line at the point in the system where the maximum portion of produced water is in the liquid phase.

Basically the Hydracepter is a small, high pressure, horizontal gas-liquid separator with a settling chamber for separation of water from the condensate in the line, so that the water-free condensate may be returned to the line and carried on with the gas. The Hydracepter is installed directly in the gas line and virtually becomes a part of it.

The Hydracepter is available in two types. Type "W," for removal of water only, permits all hydrocarbons, both liquid and gas to flow on to the plant or separator. Type "L" removes all liquid and is installed on supply lines to drilling rigs, camp fuel systems, and gas transmission lines.

(14) Line Check Valves

Durabla Manufacturing Company of New York City announces a new line check valve. There are only three valve parts in Durabla's new check valve, plus the seat and a locking ring for easy assembly. The Durabla basic



check units are machined and ready for immediate installation in all standard pipe fittings such as tees, elbows, crosses, couplings, etc., and, the manufacturer claims, they take the place of all other types including swing-checks, ball-checks, clapper-checks, etc., as well as air checks.

(15) Magnetizing Unit

Magnaflux Corporation, Chicago, Illinois, has announced a new portable unit, KH-05, developed to supply on-the-job inspection. It requires 110-v a-c supply line to give a-c or d-c magnetization with safety and flexibility, using low voltage, high amperage magnetizing currents. The new unit makes readily visible all defects such as invisible fatigue cracks, corrosion cracks, weld cracks, etc., by an indication built up on them by magnetization.

Magnetizing cables are connected as desired, being equipped with Eitherend connectors throughout. A magnetizing coil is quickly looped as needed, either around the part to be inspected or through openings in the part when that is best magnetization.

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(16) Polished Rod Clamp

The Altens Foundry and Machine Works announces a new polished rod clamp, the Alten "Wonbolt, Jr." The Wonbolt is completely self-aligning when pulled up with any type of wrench. There is only one nut to secure, and it is extra long for added wrenching surface. The clamp is made of malleable iron. The Wonbolt has the strength of conventional clamps twice its size. Small enough to revolve with the polished rod hanger, the five-pound clamp is available in either 1⅛ or 1¼ sizes.

(17) Single Large Unit Heater

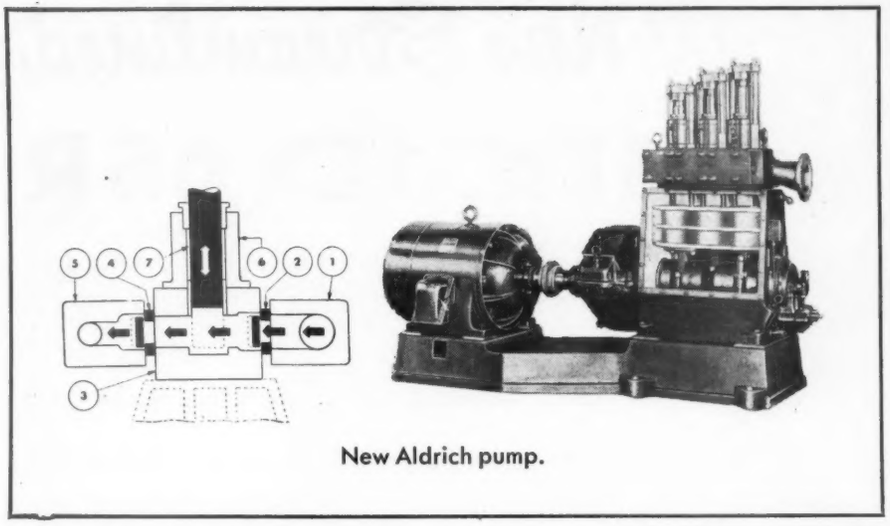
The Prat-Daniel Corporation of East Port Chester, Connecticut, announces the production of the Thermobloc Model 1000, delivering 1,000,000 btu's per hour. This unit occupies

a floor area 44 by 70 in., a little over twice that of the Model 550 and is 9 ft 7 in. high.

A number of louvered outlets around the top of the unit provide an even 360 deg distribution of low velocity, heated air, thereby eliminating excessive drafts. Discharge is at the working level, warming that area immediately without necessitating "banking" heat from the ceiling down.

(18) Direct Flow Pump

The introduction of the direct flow principle in pump design by The Aldrich Pump Company, Allentown, Pa., has resulted in numerous advantages, including greater volumetric efficiency and lower operating and maintenance costs. Designed to permit direct or through-flow of liquids, the pump features a major revision in construction. The design resulted in a reduced volume of space between valves, which made possible a higher volumetric efficiency. It also employs a sectionalized fluid end, composed of separate

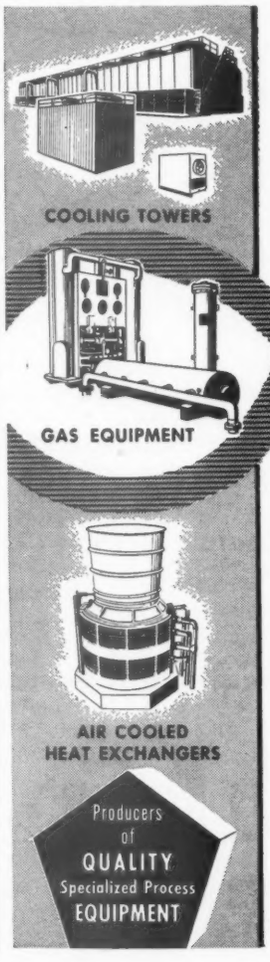


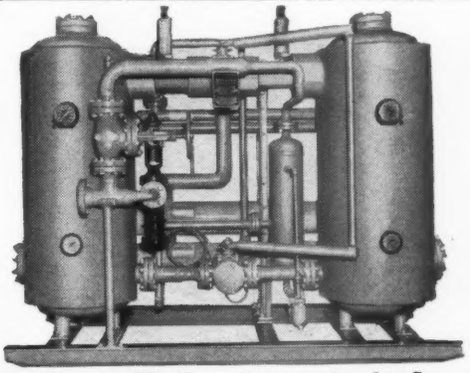
New Aldrich pump.

units that include the working barrel, stuffing boxes, valve units, plunger, and suction and discharge manifolds.

As shown in the diagrammatic drawing, the suction (1) and discharge (5) manifolds are separate units, which are bolted to the forged steel working barrel (3). The valve assemblies (2 and 4) and valve seats, which are held in place by the manifolding, are easily accessible. The stuffing box (6) is removable to permit adapting other size plungers (7) to the pump. Note that the pumping fluid flows through in a direct line, without being diverted. In performance tests, direct flow pumps have operated with a volumetric efficiency of 96 per cent. Close clearances give high efficiency with light as well as heavy liquids.

The pumps are particularly adaptable to oil industry applications such as primary and secondary recovery, recycling, salt water disposal, crude oil gathering lines, and product lines. These pumps are also suitable for handling butane, propane, lithium chloride, diethylene glycol, and other fluids.





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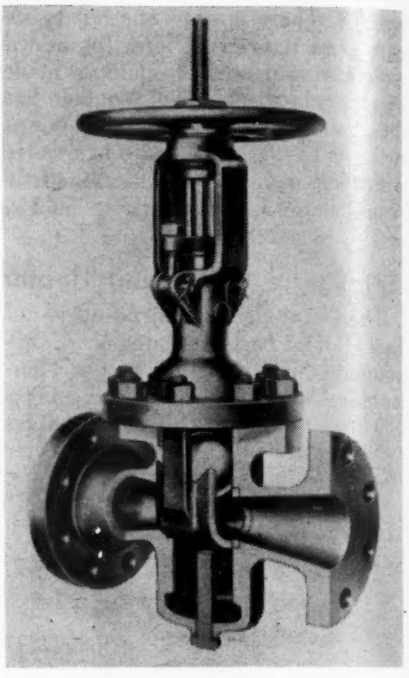
(19) General Purpose Valve

W-K-M Company, manufacturer of Christmas trees, general service and pipe line valves, announces a valve for general duty, the W-K-M Venturi-



Ball Valve. This valve is especially designed for throttling applications in high pressure, corrosive or erosive applications and features straight line discharge characteristics. In the throttling position, the ball presents a smooth surface, and non-turbulent flow is possible over a wide range without destructive erosion or wire drawing.

Wide open flow is unobstructed, non-turbulent with negligible pressure drop. When tightly closed the ball seats tightly regardless of pressure and flow conditions. Line contact between ball and seat assures tight, absolute shutoff. It is self cleaning and purging due to the venturi design. Liquids or gases passing through the venturi passages suck out dirt, scale, sediment.

(20) Valve Control

The E.I.M. valve control manufactured by the E.I.M. Company, Houston, Texas features in gas pipe line service the use of a 1000 psi gas turbine. With this equipment it is possible to provide pressure directly to the gas turbine eliminating accessories such as pressure reducing valves, regulators, etc. By this means eliminating the hazard of malfunctioning in the event of common occurrences such as regulators freezing. The equipments are also furnished with hydraulic motors that function on direct line pres-

Announcing

the new W-K-M BALL VALVE

The W-K-M Venturi-Ball design combines all these advantages in one valve...

Smooth throttling—The long life of the new W-K-M Ball Valve in high pressure corrosive and erosive throttling applications has proved its superiority. Smooth flow around ball and its straight line discharge characteristics make it the ideal throttling valve.

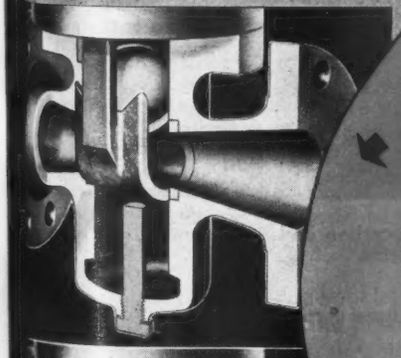
Straight-through flow—Wide open flow is unobstructed, non-turbulent with negligible pressure drop. Full flow is approximately double that of a globe valve.

Self-cleaning and purging—Due to the venturi design, liquids or gases passing through valve suck out dirt, scale, sediments. There are no corners, passages in which solids or sediments might be trapped.

Easy to open and close—The ball rolls. No appreciable sliding friction. Wedge pads on yoke make valve remarkably easy to open even under adverse conditions.

Long life—The ball seats in a different position each time, thus distributing wear over its entire surface, and preventing uneven wear of seat. Valve may be reversed in the line to double its life. Smooth flow minimizes erosion.

Operation of the W-K-M Ball Valve

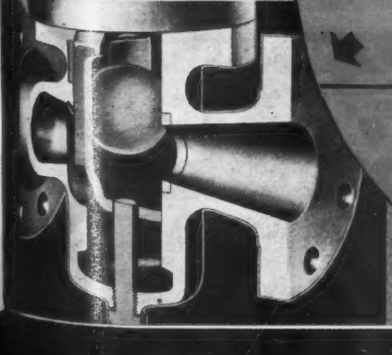


WIDE OPEN

All parts are out of stream—giving straight through unobstructed flow. Yoke member straddles stream and cradles the precision-ground ball.

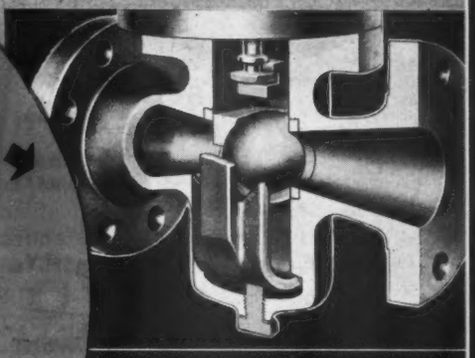
THROTTLING

In any midposition the ball presents a smooth surface. Non-turbulent flow over a wide range is possible without destructive erosion or wire drawing. Bernoulli effect constantly holds ball firmly against fingers, maintaining throttling position without chatter.



TIGHT CLOSED

Turning hand wheel moves the stem inward, closing the W-K-M Ball Valve. The ball guide, fixed in the valve body, directs the ball into the seat. Locking wedge, moving with the yoke, seats the ball tightly, regardless of pressure and flow conditions. Line contact with high unit pressure between positioned ball and seat assures drop tight, absolute shut-off.



The W-K-M Venturi Ball Valve is the most versatile of general purpose industrial valves and has proved its superiority in hundreds of challenging applications. Write for Bulletin 695 which describes more fully the many engineering advantages of this outstanding new valve.

Licensed under Paul Patent Applications.

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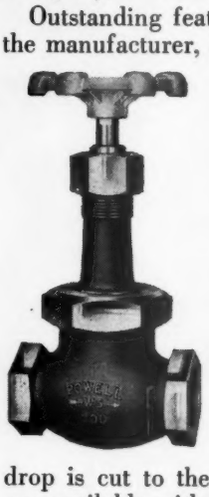
sure eliminating the need for additional electric motors and hydraulic pumps. E.I.M. valve controls have been applied to 30-in. 600 lb gate valves operating on 900 psi in oil service and to 30-in. plug valves operating on 1000 psi in natural gas service. Units, of course, are suitable for application to smaller valves in these services.

The E.I.M. Company has also published a bulletin containing essential tables for valve control.

(21) Flow Valve

A new 200-lb bronze "W.S." Globe valve is announced by the Wm. Powell Company, Cincinnati, Ohio.

Outstanding features, according to the manufacturer, are the extra high lift of the disc, the large flow areas above and below the seat, and the wide nominal pipe size opening through the seat.



Advantages that result are full flow through the seat when the valve is fully open, turbulence is practically eliminated, while pressure drop is cut to the minimum. Valves are available with screwed ends, and in sizes from ⅛ to 3 in., inclusive.

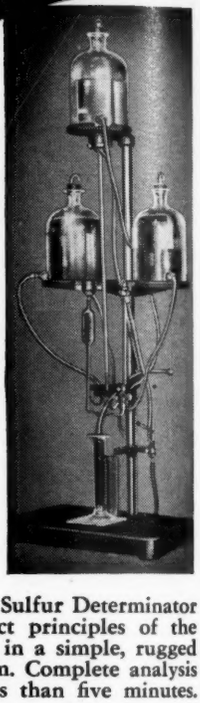
(22) Automatic Control

A new device for automatically controlling pump operation known as the "Pressureflo" Control, has been developed by Builders-Providence, Inc., Providence, Rhode Island, from the original invention of Marsden C. Smith, Chief Engineer, Department of Public Utilities, Richmond, Virginia.

The Builders "Pressureflo" Control consists of a flow-determining means, a pressure or level sensing device and a mechanism to translate this "information" into a control function. Metering devices are normally desirable on any system. Other equipment consists of standard components plus a special control device to convert flow and pressure into pump response. It may be used to start and stop pumps, to increase or decrease the speed of one or more pumps, to maintain a predetermined pressure at any point or district on a distribution system, or to automatically adjust both pressure and flow to suit varying demands.

Savings include reduced power costs and more efficient operation of the pumps.

SULFUR and CARBON Analyses in PETROLEUM PRODUCTS



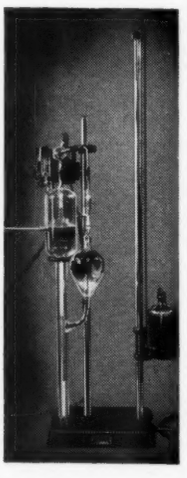
The sulfur content of oils, waxes and greases is an important measure of the value and quality of the product.

Whether the desired sulfur content be high or low, it is necessary to know exactly what amount is present.

The combustion method offers a rapid and sure means of determining sulfur in the wide range of percentages and materials encountered in the oil and grease field.

The Dietert-Detroit Sulfur Determinator embodies the correct principles of the combustion method in a simple, rugged and convenient form. Complete analysis can be made in less than five minutes.

Carbon determinations on organic compounds are being made in as little as two minutes with the Dietert-Detroit No. 3003 Carbon Determinator.



This method can be applied to any petroleum product. One example of the usefulness of this method is the analysis of cracking catalyst for carbon content.

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*Two typical users— { THE SHELL OIL COMPANY / THE PURE OIL COMPANY }

CONTROL EQUIPMENT
HARRY W. DIETERT COMPANY
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(23) Motor Driven Welder

"Lincoln Shield-Arc SAE" is the name of a bulletin published by the Lincoln Electric Company. This bulletin, No. 1302, tells the work produced by the motor-driven welder. The arc welder provides range in currents for all types of welding work whether it is thin metal or heavy plates and structures. The manufacturer states that it will cut welding costs, will speed up production, and is rugged in design. A safety push-button is provided which cannot be set "on" by an accidental bump.

(24) Variable Speed Drives

Link-Belt P.I.V. variable speed drives, available in 8 sizes and 16 types, in hp of ½ to 25, with manual and automatic controls, are illustrated, listed and described in a new 88-page Book No. 2274 published by Link-Belt Company. A special feature of the new book is the convenience with which a P.I.V. of the right specifications for a specific service may now be selected directly from its 36 pages of "Preselected Drives." Diagrams of automatic speed control applications, and pages of photographs showing a great variety of P.I.V. installations throughout the industries, are other features.

(25) Lubricating Greases

"The Fundamentals of Lubricating Greases and Their Application" are covered graphically and colorfully in new educational booklet of that title published by Shell Oil Company, New York. The new booklet, which contains no advertising and is available free, is the eleventh and latest in Shell's "Panorama of Lubrication" series, used in industry and schools for more than 15 years. It is printed on heavy, glossy paper and contains 40 pages of text, photographs and drawings, many in color.

The basic theme of the booklet is its explanation of the scientific principles that make greases a separate category of lubricants. Besides describing the make-up and general character of greases, the booklet discusses the jobs greases can do best and tells how greases are made to do particular jobs.

Other booklets in the "Panorama of Lubrication" series deal with lubrication of friction type bearings, diesel, automotive, steam, marine and aviation engines, steam turbines, and with the general subject of hydraulic oils. All the booklets are of standard size and design.

(26) All-Purpose Trenchliner

Parsons Company of Newton, Iowa, announces the publication of a new catalog describing recent improvements made on the Parsons Model 221 Trenchliner. Digging 8½ ft deep and 16 to 36 in. wide in a range of 12 variable cutting widths, the Model 221 Trenchliner is well suited to handle works project trenching assignments of cities, municipalities and utilities. High production performance records have established the 221's reliability for road and airport drainage work, underground conduit, water and gas main trenching.

Heavy-duty built, the Model 221 is fast and rugged, assures easy and quick operation, unhampered by close quarter production requirements. This all-purpose trenchliner cuts through all types of material short of solid rock. It is equipped with a selection of 15 digging feeds and, depending on depth, width, and soil conditions, has a digging capacity up to 3 cu yd per minute. The machine is equipped with 4 travel speeds and one reverse, and 3 bucket line and conveyor belt speeds. A full reverse on all operations makes undercutting easy.

(27) Oil-Well Pumping

Oil well electrification as it applies to oil-well pumping is the subject of a new 47-page illustrated booklet now available from Westinghouse Electric Corporation. Published to provide practical help to oil-well operators in improving pumping operations, it covers every phase of electrification from motors to power supply, and provides useful information to assist in electrifying any oil lease.

One section discusses the application of electric motors for sucker rod pumping. It includes a discussion of motor enclosures, and speed-torque characteristics of squirrel cage induction motors. A section follows that explains methods of determining the necessary motor horespower ratings.

(28) Stainless Steel Valve

The Cooper Alloy Foundry Company, Hillside, New Jersey, announces publication of its new stainless steel valve, fitting and accessory catalog. Complete in every detail, this attractive 48-page catalog contains engineering drawings, weights, dimensions, size ranges, materials, corrosion data, nomenclature, and design information woven into an easy-to-read and easy-to-follow booklet.

Copies are available on request.

(29) Self-Priming Pumps

Rice Pump & Machine Company, Milwaukee 15, Wisconsin, announces that new catalog bulletins including the Rice 3 in.-15M self-priming centrifugal pump, as well as the 7M and 10M sizes are available. The company is now building standard sizes of A.G.C. rated pumps through the 3 in.-15M size, featuring modern, lightweight air-cooled gasoline engine power. These sizes are also available with pulleys for belt drives and flexible couplings for direct-connected electric motor drives.

(30) Steam Jet Syphons

A full line of SK steam jet syphons, which operate on the jet principle utilizing the energy of steam under pressure to pump, heat, mix liquids, and handle solids is described and illustrated in new Bulletin 2-A recently issued by Schutte and Koerting Company, Philadelphia, Pennsylvania.

The 24-page catalog is divided into three sections. Section 1 details the design, application, construction, and operation of the various types of syphons available. Special purpose and corrosion resistant syphons are covered in Section 2. Each special purpose syphon is described and illustrated. Typical applications of steam jet syphons in the pumping, heating, and mixing of liquids and the handling of solids are included in Section 3, of special interest to plant and process engineers.

(31) Hard-facing Metal Parts

A new 40-page hard-facing manual has just been published by the Haynes Stellite Division, Union Carbide and Carbon Corporation, Kokomo, Indiana. The booklet tells the complete story of hard-facing. It describes how to select the right alloy; which welding process to use; and gives simple, step-by-step instructions for applying the various rods by both the oxy-acetylene and metallic-arc welding processes. Information is given on the properties and available sizes of 12 Haynes hard-facing materials.

(32) Chemical Pump

Bulletin P-332 on sanitary pumps for chemical processing has been released by the Waterous Company of St. Paul, Minnesota. Having one piece rotor and shaft and sanitary seals with no threads and few parts there is no product accumulation or contamination. The pump has accurate volume control, easy accessibility, and is easily cleaned.

(33) Turbine Pumps

A 20-page booklet with illustrations showing construction details, various types of drive, and typical installations of deep well turbine pumps, has been released by The Deming Company, Salem, Ohio.

Although widely used for pumping water supply from deep wells for all types of industries, institutions, stores, country clubs, estates, and numerous other places, these pumps have additional applications. They are used successfully in fuel oil and gasoline pumping systems in airports, loading tank cars, in sump pumping service, and other types of pumping operations.

Pumps are supplied for wells with inside diameter of 4 inches or larger. Capacities vary from 12 to 1300 gallons per minute. Within this range almost any combination of capacity head and speed can be obtained.

(34) Short Coupled Pumps

The 16-page bulletin issued by Layne and Bowler, Inc., Memphis, Tennessee, entitled "Layne Short Coupled Service Pumps", contains cut-away drawings of pump bowls and discharge columns. Sixteen sketches show the Layne vertical turbine pump applied to river, and re-lift service, boosting, recirculation, cooling tower, drainage, gas and oil pumping, and fire pumps.

(35) Power Shovels and Cranes

A new 18-page catalog on the Lorain-TL series of power shovels and cranes has been announced by The Thew Shovel Company, Lorain, Ohio. This series of machines in the ½ and ¾-yd classes may be mounted on a wide variety of crawler and rubber tire mountings according to varying ground and travel needs; it includes self-propelled and moto-crane models. The interchangeable "units" or "packaged" assembly pioneered by the Lorain-TL series is graphically illustrated. This design feature has been instrumental in changing the conception of servicing power shovels and cranes.

(36) Boiler Feed Water Control

A bulletin describing and illustrating the one, two, and three-element boiler feedwater control system has recently been released by the Republic Flow Meters Company, Chicago, Illinois. A comparison of the three systems and the advantages of each are featured in this 8-page brochure.

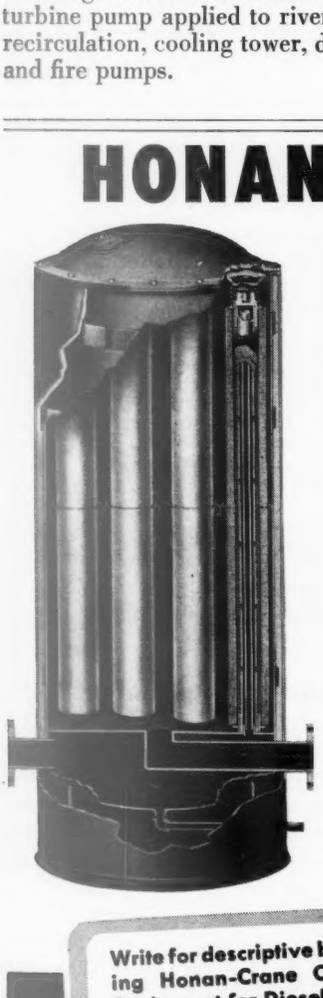
(37) Fuel Oil Treatments

Two fuel oil treatments for use by refiners, distributors, or consumers of distillate or residual fuel oils are described in a bulletin "Nalco Fuel Oil Additives" by National Aluminate Corporation, Chicago, Illinois.

Both Nalco fuel oil treatments are effective in preventing corrosion and in removing old oil sludge.

Nalco SR-155 contains a combustion catalyst resulting in more complete burning of fuel. In addition, it stabilizes fuel oil and prevents sludge formation and corrosion. Nalco SR-158 is designed to stabilize fuel oil, preventing sludge deposits in storage tanks and clogging of lines, screens, and filters. It does not contain the combustion catalyst.

HONAN-CRANE Oil Purification offers



3 *types of interchangeable*
CARTRIDGE REFILLS
for correct handling of every purification problem

Three types of cartridge refills, designed by Honan-Crane especially for Honan-Crane purifiers, make it possible for you to select the filtering medium best suited to your purification needs. Cartridges are interchangeable and may be used to remove either solids or products of oxidation . . . maintaining any oil in approximately new condition.

Easy-to-handle Honan-Crane refill cartridges are your assurance of thorough oil purification at lowest cost.

Honan-Crane Type "M" Continuous Oil Purifier
Multiple-cartridge purifier, available in eleven sizes using 1 to 24 cartridges. Provides high flow rate and is designed to use easy-to-change "MC", "MF", or "S" type cartridges.

Type "MC" Type "MF" Type "S"

Honan-Crane Type "MC" Cartridge
"MC" Cartridge is a woven cotton bag containing 15 pounds of Cranite (specially processed fullers earth). Solids and abrasives as well as soluble products of oxidation such as asphaltenes, resins and acids are removed from the oil.

Honan-Crane Type "MF" Cartridge
"MF" Cartridge is a perforated metal basket lined with a woven cotton sock material and uniformly packed with Palconia (specially selected cellulose fiber filtering medium). Complete removal of solids such as abrasives, scale and other foreign matter.

Honan-Crane Type "S" Cartridge
Type "S" Cartridge contains 4½ pounds of Palconia tightly packed in a specially woven cotton sock material. Performance of the cartridge is comparable to the "MF" cartridge in removal of abrasives, scale and other foreign solids.

Write for descriptive bulletins covering Honan-Crane Oil Purification Equipment for Diesel Lube and Fuel Oils, Turbine Oils, Cutting Oils, Quench Oils, Coolants, etc. State type of purification problem.

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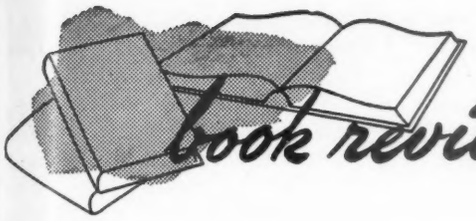


Practical Report Writing, *by Selby S. Santmyers. International Textbook Company, Scranton, Pennsylvania. Pages, 118. Price, $2.75.*

The book has been written for the man or woman who has to write reports, in order that he or she may be able to write them in a manner that will produce the desired effect, the author states.

Emphasis is placed upon the importance of the outline in planning the technical report, background needed by the writer of reports, gathering and organizing of material, and with the rough draft of the report. The author then shows how the report may be put into an understandable and presentable written form.

Patent Practice and Management, *by Robert Calvert. Scarsdale Press, Box 536, Scarsdale, New York.*

This book presents the management of invention and patents, from the viewpoint of the inventor and executive and in their language. It presents, not only the essentials of patent law, but also such features as selection of subjects to be patented, use and misuse of patents, and hazards and modes of protection in use of information received in confidence.

Three chapters are devoted to writing specifications and claims, with an outline and a complete application written from the outline. Also receiving thorough treatment, are subjects on patent office procedure, reissues and disclaimers, patent policies of institutions, medical, educational, and government. A chapter is devoted to tax law of research and invention, and to the advantages and disadvantages of filing applications for foreign patents.

Petroleum and Petroleum Products, *by A. G. White, F. S. Lott, A. T. Coumbe, and A. L. Clapp. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Pages, 111. Price, $.25.*

This booklet is a reprint from the Bureau of Mines Mineral Yearbook, 1947. The outstanding feature of 1947 was the record increase in oil demand to a much higher level than had been anticipated. Compared with 1946, the domestic demand for motor fuel rose 8 per cent, for residual fuel oil 8 per cent, for distillate fuel oil 23 per cent, for kerosine 15 per cent, and for all other products 12 per cent. In general, the postwar adjustments in demand resulted in a small gain in domestic demand in 1946, when a sharp drop had been considered probable, and a much larger gain in 1947 had been anticipated.

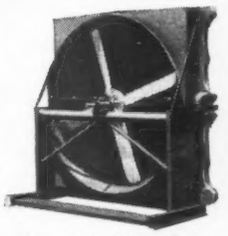
Our Oil Resources, *Second edition, 1950, published by McGraw-Hill Book Company, Inc., New York, Toronto, London, Edited by Leonard M. Fanning, pages, 408. Price $5.*

This second edition containing an exhaustive study of our oil resources, is written in terms of human resources—engineering and scientific learning, plus private initiative and incentive. With a full coverage of changes made in the technology of exploration and production this book shows the role of petroleum in our daily life, traces the part of private enterprise in the development of U. S. oil resources and analyzes conservation, the role of technology in oil, natural gas, coal and shale reserves, and operations of American oil companies in foreign countries.

Specify YOUNG FOR COMPLETE COOLING FROM A SINGLE SOURCE

Pipe line terminal station of the Union Oil Company of California at Avila, California, using Young Jacket Water Coolers and Heat Exchangers.

Integrated installations of several kinds of heat transfer equipment are common in Young Engineering experience. The Union Oil Company (see above) uses jacket water coolers to cool three 450 hp Diesels pumping up to 21,000 barrels per hr. The top half of each cooler handles the lube oil cooling water, the lower half cools the engine jacket water. A Young heat exchanger, rated to the job, cools the lubricating oil. Standard parts make possible quick delivery, economical maintenance. Find out if you're getting the most for your cooling dollar, mail coupon for full details.



Young Jacket Water Coolers, for gas, gasoline, or Diesel engines, available in many sizes for single or multiple use.

Young Shell and fixed or removable Tube Bundle Heat Exchangers are made in single- or two-pass styles; stocked for quick delivery and economy.

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Heat Transfer Products for Automotive and Industrial Applications.

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I am interested in your combination cooling. Send me literature on both Jacket Water Coolers and Heat Exchangers.

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Company_____

Address_____

City_____ Zone____ State_____

Chemical Engineers' Handbook, *revised third edition, John H. Perry, editor. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, New York. Pages, 1942. Price, $15.*

The new third edition of the Chemical Engineers' Handbook provides a virtually complete revision of this reference work, including a comprehensive coverage of both standard and recently compiled facts, figures, and methods applicable to both chemical engineering and its related fields.

Included in the revised edition, are (1) increased coverage and new treatment of low-temperature refrigeration and processes; (2) extensively revised material on flow of fluids, heat transmission, etc.; (3) new presentation of humidification dehumidification, spray ponds and cooling towers; (4) a thorough revision of material on fuels, electrochemistry, etc.; (5) greatly expanded material on size reduction, and power regeneration.

More than 2000 charts, diagrams, cross-sections, flow sheets, etc., are included, and all drawings have been newly prepared and increased in size to present every detail more clearly.

Mobile Radio Handbook, *First Edition, Milton B. Sleeper. Published by FM-TV Magazine, Great Barrington, Mass. Pages, 190. Price, $2 paper bound, $4 cloth bound.*

A reference book written for company executives and public officers concerned with communication equipment. Although 2-way radio telephone communications have grown to the point where more than 12,000 main stations and over 200,000 mobile units are now in use, this seems to be the first book to be published on the planning, operation, and maintenance of communications systems.

ROPER Rotary PUMPS

SUPPLY FUEL TO BALDWIN LOCOMOTIVES

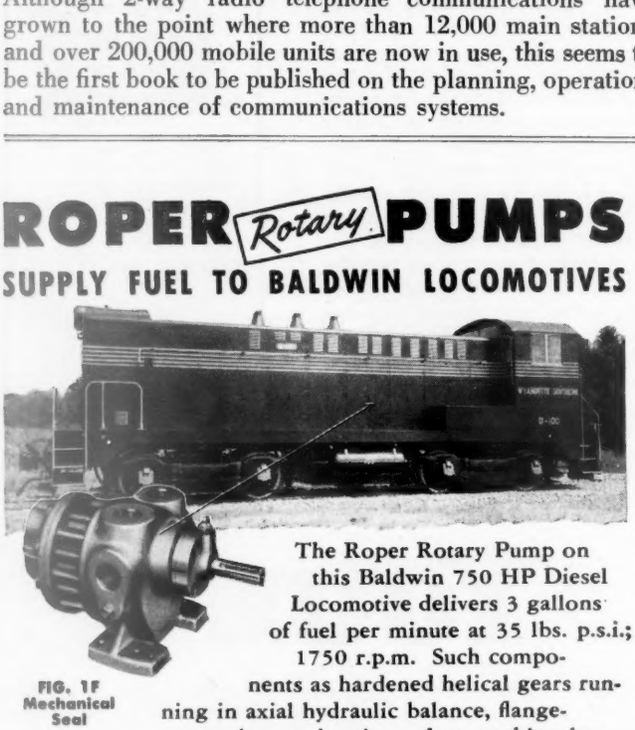

FIG. 1F Mechanical Seal

The Roper Rotary Pump on this Baldwin 750 HP Diesel Locomotive delivers 3 gallons of fuel per minute at 35 lbs. p.s.i.; 1750 r.p.m. Such components as hardened helical gears running in axial hydraulic balance, flange-type bronze bearings, deep packing box with split rings and split gland, and 4-port design for ease of installation are but a few reasons why Roper Pumps are selected by Baldwin. Investigate the Roper Series F Pump today! Capacities 1 to 300 g.p.m., pressures to 300 p.s.i.

Send for Literature Today

GEO. D. ROPER CORP.
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ROCKFORD, ILLINOIS
DEPENDABILITY SINCE 1857

ROPER Rotary Pumps

Petroleum and Its Products. *Delivered by William J. Sweeney, Standard Oil Development Company, New York, N. Y. Price, $2.50.*

The text, figures, and tables in this publication were a presentation of the twenty-fourth annual Priestley lectures, a series of lectures inaugurated in 1927 and dedicated to the memory of Joseph Priestley. The original concept for the Priestley lecture series were three-fold (1) to establish a living memorial for Joseph Priestley, (2) to honor a succession of contemporary American scientists and (3) to demonstrate that theoretical chemistry was a vital part of modern applied chemistry. This issue covers a wide variety of subjects and fields including: Occurrence, production, and resources of petroleum, composition and analysis, refining chemical products from petroleum, and utilization of petroleum products.

Report of Petroleum and Natural-Gas Branch Fiscal Year 1948, *by R. A. Cattell and others. U. S. Department of the Interior. Reprinted from Bureau of Mines Information Circular 7532. Pages, 66.*

This reprint is a summary of a well-coordinated research program during the past fiscal year on problems dealing with the production of oil and gas, and transportation of natural gas. It also discusses chemistry and refining of petroleum, thermodynamic properties of hydrocarbons, and the processing and utilization of incombustible helium gas. Complete reports on Lake Creek, Sheridan, and West Red River fields, Texas; Atlanta field, Arkansas, and the Botts field, West Virginia, are also included.

Petroleum Subsurface Engineering, *by Harold Vance. Educational Publishers, Inc., St. Louis, Missouri. Pages, 168. Price, $4.25.*

Subject matter of this book concerns determining the size, shape, and volume content of petroleum reservoirs. There are numerous topics in the book dealing with all phases of geology, even though the author says it is written primarily for the senior students in petroleum engineering. Some of the topics discussed are maps and land surveys, well logging and log interpretation, subsurface cross sections and models, properties of petroleum, oil reservoirs, and relative value of reservoir space.

Best's Safety Directory, 1950-1951, *third edition, Alfred M. Best Company, Inc., 75 Fulton Street, New York, New York. Pages, 511. Price, $5.*

The new directory covers the entire field of safety, fire protection and control, hygiene, first-aid, and sanitation. The detailed indexing and subject-grouping system, plus countless illustrations, make it easy to locate safety products even when the user is not certain of the type or name of the product he needs. Serving as a combined safety manual, directory, index, encyclopedia, and catalog in one, the fully illustrated book shows what safety products or devices to use for specific hazards; how to use them, and where to get them.

A History of Steel Casting, *compiled and edited by Arthur D. Graeff. The Kutztown Publishing Company in Kutztown, Pennsylvania. Pages, 167. Price, $2.50.*

This 168-page volume contains a detailed primer of steel casting production covering original methods and vast advances subsequently effected in furnace practice, process molding, pouring, pattern making, cleaning, testing and inspection, etc. Illustrated throughout, the book contains close to 50 photographs of individual plants, personalities, and processes, distinguished scratchboard drawings, and sketches. Also included is a detailed geographical division of the Steel Founder's Society of America, and an appendix listing past officers and directors.